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Value-Centric Behavior change with Data Visualization

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Dietary choices are a leading global cause of mortality and environmental degradation that threaten the attainability of the UN's Sustainable Development Goals and the Paris Climate Agreement [1]. It thus becomes important to find ways to reduce its environmental impact and facilitate healthy consumption patterns. Humans use values as guiding standards, in making judgements [4] which in turn contribute to product choices in the grocery shopping process. The focus of this thesis is to help consumers of large retail supermarkets to make informed choices, aligned with their personal goals, to develop a value-centric purchasing habit with the ultimate aim of lowering the impact on the environment and the negative effects on the health of the consumers.

By using the design thinking process along with the behaviour change wheel framework it was possible to empathize with and understand the target user group to identify design features for the mobile application suggested by this thesis. To achieve value centric purchasing habits, the most promising observation was to provide all the necessary information at the grocery planning phase. This would enable informed-choice-making, in line with the personal goals of the consumers while making grocery lists. It is assumed in this thesis that consumers purchase the same brand and product added to their shopping list.

Along with the information on products, visualisations of the target shopping patterns against their actual shopping patterns are presented to the user. This would in turn help consumers make the right decision by providing an overview of how their product choices influence in reaching their target goals. Based on commonly used and easily understandable visualisation methods, a radar chart and line chart depicting their past purchase patterns and goals were evaluated against each other with usability tests. The visualisations and interactions were supplemented with clear legends to ensure that the consumers perceived what was intended. Use of animations on these visualisations was suggested to increase the understanding and effectiveness in the communication of its data. While both these methods had their own strengths and weaknesses the radar chart was better received and was thus suggested for use in the development of the application.

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Value-Centric Behaviour Change with Data Visualization

Case study for visualizing data on grocery consumption to bring about value-centric purchasing patterns for retail supermarket consumers

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ABSTRACT

Dietary choices are a leading global cause of mortality and environmental degradation that threaten the attainability of the UN's Sustainable Development Goals and the Paris Climate Agreement [1]. It thus becomes important to find ways to reduce its environmental impact and facilitate healthy consumption patterns. Humans use values as guiding standards, in making judgements [4] which in turn contribute to product choices in the grocery shopping process. The focus of this thesis is to help consumers of large retail supermarkets to make informed choices, aligned with their personal goals, to develop a value-centric purchasing habit with the ultimate aim of lowering the impact on the environment and the negative effects on the health of the consumers.

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Värderingsdriven beteendeförändring med datavisualisering

En fallstudie för att visualisera data om livsmedelskonsumtion i syfte att åstadkomma värderingsdrivna köpmönster för konsumenter i detaljhandeln

Sammanfattning

Kostval är en viktig orsak till dödlighet och miljöförstöring på global nivå, vilket hotar möjligheterna att uppnå både FN:s utvecklingsmål kring hållbarhet och Parisavtalet [1]. Det är därför viktigt att finna sätt att minska kostens miljöpåverkan och underlätta mer hälsosamma konsumtionsmönster. Människor använder sina egna värderingar när de gör bedömningar [4] som i sin tur avgör vilka produkter de väljer i dagligvaruhandeln. Fokus för detta examensarbete är att hjälpa konsumenter i dagligvarubutiker att fatta välgrundade val, i linje med deras personliga mål och värderingar, med det slutliga målet att minska miljöpåverkan och negativa hälsoeffekter för konsumenterna.

Genom att använda en "design thinking"-process tillsammans med beteendeförändringsramverket "behaviour change wheel" var det i examensarbetet möjligt att empatisera med och förstå målgruppen, för att identifiera designfunktioner för den mobilapplikation som föreslås i detta examensarbete. För att uppnå värdecentriska köpvanor var den mest lovande observationen att tillhandahålla all nödvändig information i livsmedelsplaneringsfasen. Detta skulle möjliggöra informerade valmöjligheter, i linje med konsumenternas personliga mål samtidigt som de gör inköpslistor. Det antas i detta examensarbete att konsumenter köper samma märke och produkt som läggs till i deras inköpslista.

Tillsammans med informationen om produkter presenteras visualiseringar av målen för inköp mot användarnas faktiska inköp. Detta kan i sin tur hjälpa konsumenterna att fatta rätt inköpsbeslut genom att ge en översikt över hur deras produktval påverkar när de når sina mål. Baserat på vanligt använda och lättförståeliga visualiseringsmetoder utvärderades ett radarkarta och ett linjediagram som visar användarnas tidigare inköpsmönster och mål, mot varandra med användbarhetstester. Visualiseringarna och interaktionerna kompletterades med tydliga diagramförklaringar för att säkerställa att konsumenterna uppfattade vad som var avsett. Användning av animationer på dessa visualiseringar föreslogs för att öka förståelsen och effektiviteten i kommunikationen av dess data. Medan båda dessa metoder hade sina egna styrkor och svagheter mottogs radarkartan bättre och föreslås därför för användning i utvecklingen av applikationen.

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1. Introduction

A wide range of influences affects people's choices and actions. Cultural and social norms, past experiences and financial status are sometimes the most important factors. Something that is common to all these are our values that shape the behaviour and attitudes in our lives. [4] In the context of this thesis, values are defined as importance and attitudes towards nutrition, environmental impact and fairness in production of products at a retail supermarket are evaluated.

Food production and consumption patterns have a great impact on both the environment and the health of the consumers[2]. Use of digital tools to change behaviors and consumption patterns are becoming commonplace [2].

Since humans use values to influence choices on their ecological footprint, personal wellbeing and feelings [4], a behavior change with digital interventions to drive consumption that reduces the impact on the environment and the negative impacts on the health of the consumers can be brought about by promoting value-centric purchase patterns.

This thesis discusses how a mobile application can be designed to engage and inform the consumers to help them make choices in accordance with their values. This is achieved by providing information for products on the values of nutrition, carbon footprint, water footprint and fairness in production. It probes on the various phases of the grocery shopping process to identify which phase requires intervention for reaching the desired target behavior. The phases of the shopping process considered for this thesis are (1) the planning phase - making grocery lists, (2) the shopping phase - visiting the grocery store and (3) the Inventory phase - analysing shopping bills/purchases after they have been done. The mobile application also uses the help of the visualizations to educate its users on their purchasing patterns by visualising the values of nutrition, carbon footprint, water footprint and fairness in production for the products they buy versus the goals they want to achieve for these values. The ultimate aim of this is to increase the users' capabilities and motivations to bring about a behavior change.

This thesis has been in collaboration with Consupedia AB. They are developing a mobile application with which consumers can keep track of their purchasing behaviour. For that purpose, they have a database with information on groceries in three categories namely, health and nutrition, environmental impact and fairness in

production. This data will be used as the basis for the design of the visualizations of the mobile application.

1.1 Research Questions

The research questions addressed by this thesis are as follows:

- 1) In which phase of the grocery shopping process do users look for information?
 - 1.1) Will the choice of product change based on the information presented to them?
- 2) What kind of visualization methods on the data of groceries will best enable consumers to make informed choices?
- 3) To what degree do consumers understand this information gathered while using the suggested application?

1.2 Goals

The goal of this design-oriented thesis is to propose a design for mobile application which helps consumers of retail supermarkets to make informed choices in accordance with their goals on values of nutrition, environmental impact and fairness in production of a product found in these supermarkets. The study also concretely examines the mobile application developed by Consupedia at the time of writing this Thesis to analyse its design features and interface design element to borrow those that found useful by consumers.

1.3 Research Methodology

The research questions are examined using a mix-methods approach with complementing qualitative methods in a design thinking process. The process consists of five phases which are discussed in detail in section 2. *Theory*. As part of the process structured methods are employed in each phase such as “Online questionnaire”, “Cognitive task analysis”, “Personal Inventory” in *the empathise phase*; “COM-B behavioral diagnosis” in *the Define Phase*; “Workshop” consisting of “Brainstorming and Card Sorting” in *the Ideate phase*; “Lo-fi and hi-fi prototypes” in the *prototype phase* and “Cognitive walkthroughs and Semistructured interviews” in *the Testing Phase* were used to collect data. Alongside this, a free exploration of the Consupedia(company) application was performed to identify useful design features that could be borrowed for the design suggested by this thesis.

An overview of the data collection methods are the research questions they target are presented in Table 1. More details on the methods are presented in *Section 4.Methodology*

Targeted Research Question	Method	Design thinking phase	Primary Aim
RQ (1)	Online Questionnaire	Empathise	User Research
	Personal Inventory	Empathise	User Research
	Cognitive Task Analysis	Empathise	User Research
	COM-B Analysis	Define	Evaluation
	Brainstorming	Ideate	Design
	Card Sorting	Ideate	Design
RQ (1.1)	Semi-structured interview	Prototype	Design
	Open-ended questions	Test	Evaluation
RQ (2)	Free app exploration	Prototype	Design
	Open-ended questions	Test	Evaluation
	Close-ended questions	Test	Evaluation
RQ (3)	Likert Scale	Test	Evaluation

Table 1: Overview of data collection methods associated with research questions

1.4 Thesis Structure

Section 2 describes the Theory used in the methods employed by this study

Section 3 describes the background application examined from Consupedia (Company associated with this study)

Section 4 describes the Methods used in each phase of the design thinking process for the purpose of this Thesis. The choice of methods was based on the objectives and goals of each of the phases.

Section 5 describes the Prototype Development process in the design thinking process framework. This section first presents the outcomes of the first three phases (Empathise, Define, Ideate) of the design thinking process which is used to identify design features of the prototypes designed. Finally it presents both the Lo-fi Prototypes, the feedback received on it and the Hi-fi prototype.

Section 6 describes the Results of the tests based on the Hi-fi prototype designed. This section also answers the research questions set out by this study.

Section 7 discusses the results and the methods used to arrive at the results in this study. It also provides critique on the methods and the future work that can be done.

Section 8 concludes this study

Section 9 presents the References used in this study and The Appendices that follow describe the questionnaires, tasks and instruction sheets given to participants.

2. Theory

This section outlines the related research and background study that was done for this thesis. This theory is then used in the *Methods in Section 4*.

2.1 Behaviour Change

By systematically applying theory and evidence to design and evaluate intervention functions a behaviour change can be brought about [3]. Michie et al have defined a framework called the Behaviour Change Wheel (BCW) which provides a systematic way of characterising interventions that enable the outcomes to be linked to mechanisms of action [3]. This framework has been used in this study to identify design features that could drive the behaviour change.

2.1.1 Behaviour change Wheel

The BCW helps in defining the target user group and target behaviour for the problem at hand. In the context of this study, this is defined as enabling consumers of large retail supermarkets to choose products based on their personal goals to make an impact on the values of nutrition, sustainability and fairness in production of the grocery items.

The Behaviour change wheel shown in fig 1 consists of three layers. The hub of the wheel uses the COM-B model to identify the sources of behaviour that could prove fruitful targets of intervention. Surrounding this is a layer of nine intervention functions to choose from based on the outcomes of the COM-B analysis. The outermost layer identified seven types of policies that once can be used to deliver the intervention functions.

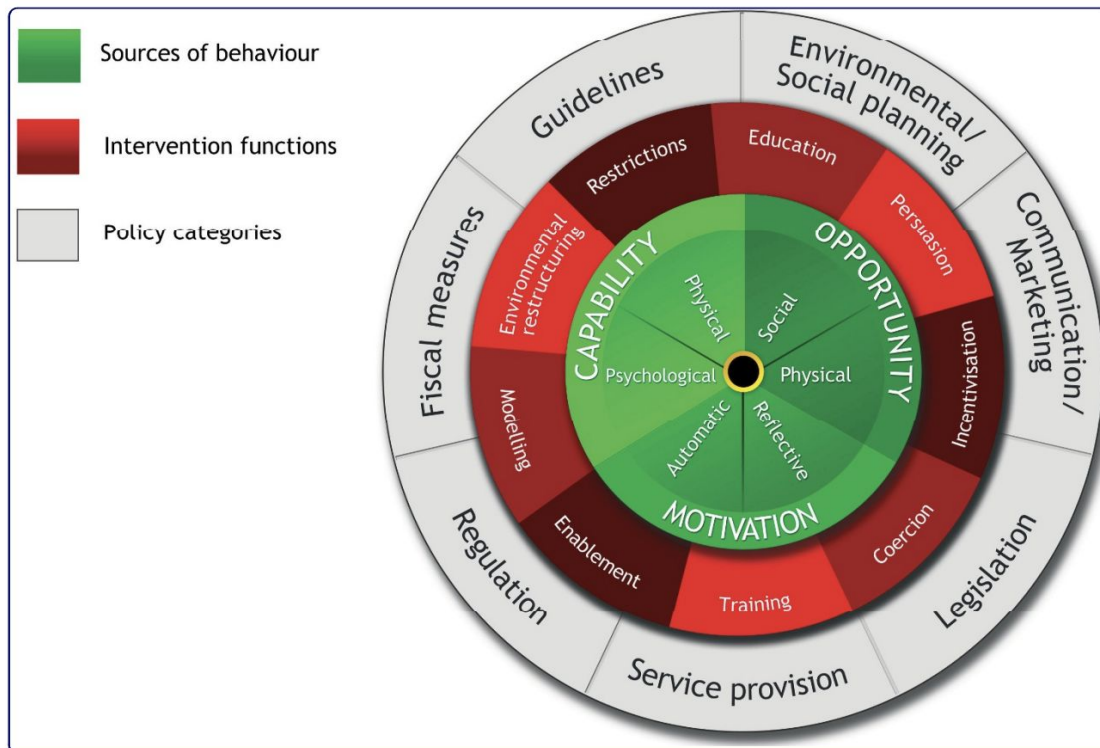


Fig 1: The Behaviour change wheel[3]

2.1.2 COM-B model

The starting point of the BCW is the COM-B which stands for Capability Opportunity Motivation - Behaviour [3] This is used to identify the components that need to change for the target behaviour to occur and is called the behavioural diagnosis.

The principle behind the COM-B model is that “Changing the incidence of any behaviour of an individual group or population involves changing one or more of the following: capability, opportunity, and motivation relating to either the behaviour itself or behaviours that compete with or support it” [3]

The behavioural diagnosis on the system is used to identify the components that have to be intervened on to reach the target behaviour [3].

It is important to note that all the components of the COM-B model must be diagnosed together in a system as a whole. For example, just increasing motivation and changing behaviours cannot increase the capability or opportunity thus making it impossible to reach the target behaviour. This is illustrated by the interlinking arrows between the components shown in figure 2

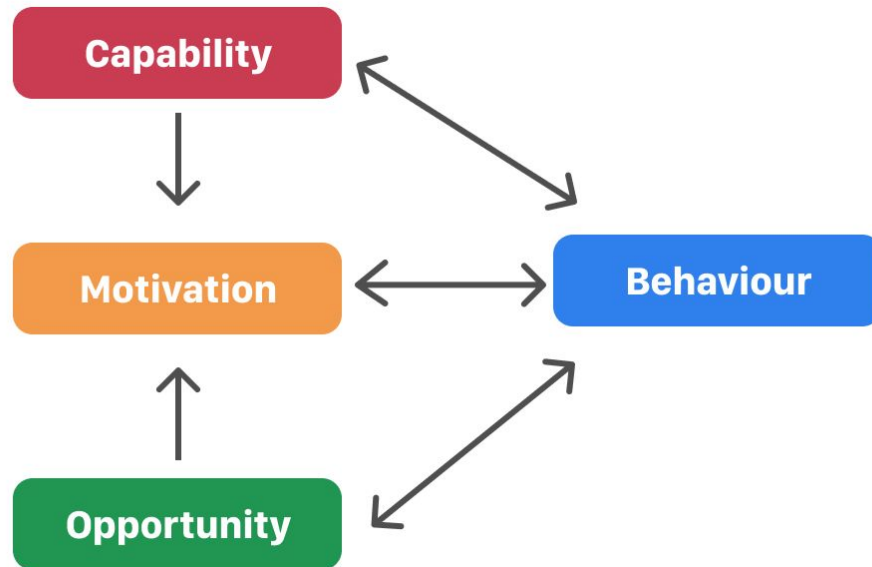


Fig 2: Interaction between the COM-B components[3]

The outcomes of the behavioural diagnosis are used in choosing the components which need change in categories like physiological capability, Automatic/Reflective motivation, Social opportunity etc which have to be changed, increased or decreased to bring about the change in behaviour.

In the context of using behavioral diagnosis for designing the interface of the application suggested by this study, the outcomes of the diagnosis was used to ideate for design features that could be used in developing the final prototype. This was done by defining the objectives of the design features as questions posed for ideation to bring about the desired change, that is, to either increase or decrease the components identified for change.

Miche et al. have designed a worksheet for the behavioural diagnosis shown in figure 3 which was used as a template for this study. The outcomes identified in this study are used to ideate for design features of the proposed application design. These results of the diagnosis done for this study have been discussed in section 5.2.1.

Worksheet 4 – Identify what needs to change

Task: Use the COM-B model to identify what needs to change in order for the target behaviour to occur:

COM-B Components	What needs to happen for the target behaviour to occur?	Is there a need for change?
Physical capability		
Psychological capability		
Physical opportunity		
Social opportunity		
Reflective motivation		
Automatic motivation		
Behavioural diagnosis of the relevant COM-B components:		

Figure 3: Worksheet for the behavioural diagnosis of relevant COM-B Components

2.2 Data visualization

The definition of data visualization used in the context of this thesis is :

“The representation and presentation of data that exploits our visual perception abilities in order to amplify cognition.” [17]

Data visualization allows users to visually observe patterns when used as a tool for discovery[17].In the context of this thesis, this is useful to portray the estimations for the different values of nutrition, carbon footprint, water footprint and fairness in production to allow for users to observe patterns in their shopping habits. Data visualization is a design process. “The process of identifying the most effective and appropriate solution for representing our data is unquestionably the most important feature of visualization design” [17]

The design of the data visualization thus takes into consideration the following [17]:

- Choosing the correct visualization "method" for the stories we're telling
- Accommodating the physical properties of the data
- Facilitating the desired degree of precision
- Creating an appropriate metaphor to depict the subject stylistically

2.2.1 Choosing data visualisation methods

Selecting the visualization method depends on what the data intends to communicate by identifying the most suitable way to answer the questions “ how are you going to show, what it is you want to say” [17]

Method classification	Communication purpose
Comparing categories	To facilitate comparisons between the relative and absolute sizes of categorical values. The classic example would be the bar chart.
Assessing hierarchies and part-to-whole relationships	To provide a breakdown of categorical values in their relationship to a population of values or as constituent elements of hierarchical structures. The example here would be the pie chart.
Showing changes over time	To exploit temporal data and show the changing trends and patterns of values over a continuous timeframe. A typical example is the line chart.
Plotting connections and relationships	To assess the associations, distributions, and patterns that exists between multivariate datasets. This collection of solutions reflects some of the most complex visual solutions and usually focuses on facilitating exploratory analysis. A common example would be the scatter plot.
Mapping geo-spatial data	To plot and present datasets with geo-spatial properties via the many different mapping frameworks. A popular approach would be the choropleth map.

Table 2: The primary communication purpose for different the different visualization methods

For the purpose of this study, classifications of showing changes over time with a line chart and plotting connections and relationships with a radar chart are chosen for comparison.

2.2.2 Line Chart

Line charts are used to compare a continuous quantitative variable on the x-axis and the size of values on the y-axis [17] In this study, the x-axis would represent time and

the y-axis the estimations of the values of nutrition, carbon footprint, water footprint and fairness in production.

The vertical points are joined up using lines to show the shifting trajectory through the resulting slopes. Line charts can help unlock powerful stories of the relative or (maybe) related transition of categorical values [17] This is shown in fig. 4

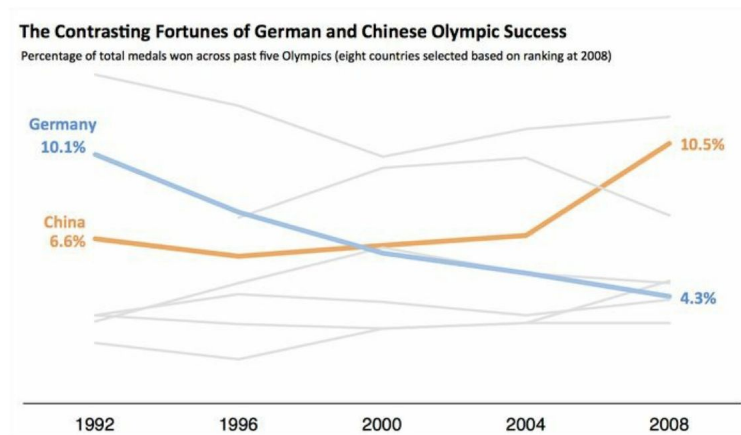


Figure 4: Line chart [17]

For this study, a multi-dimensional dataset (estimation on the values of nutrition, environmental impact and fairness in production for each product) is used. Therefore, a line chart for each dimension is plotted in separate views which together provide an overview of the entire dataset; with the aim of providing an overview of consumers' shopping patterns.

2.2.3 Radar Chart

A geometric projection method for expressing the data points in the multidimensional space is called a Radar Chart. This visual method can map the points of a multidimensional space to the two-dimensional space by expressing the attribute values of the multi-dimensional data using two-dimensional graphics [18].

To use the radar chart, a circle is drawn and split into N equal points. The points are then connected to the centre and radius is an axis that represents a dimension of the data being considered. For example Figure 5 shows the composition of oil containing A, B, C, D, E [17]

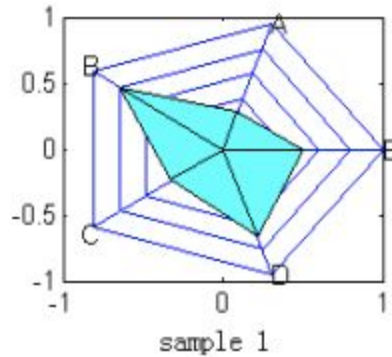


Fig 5: Sample of a radar chart[17]

For this study, radar charts are used to show all dimensions (e.g. nutrition, fairness in production, carbon footprint, water footprint) of the product in a single view for an overview of shopping patterns based on an estimation of these values for all products purchased.

2.3 Design thinking

Design thinking is an ideology that asserts a user-centred approach to problem-solving [6].

Two popular user-centered approaches are Lean Startup strategies and design thinking. While both are innovation driven user centered strategies that test concepts at early stages to get feedback from users and focus on creating early rough prototypes to perform extensive user testing and improve their concepts early to not waste time in developing something that is not usable, the design thinking process has its advantages [32].

In the Lean Startup method, the starting point is a business idea as opposed to the Design Thinking Process which identifies early adopters, their pain points and unmet needs [33]. Thus the design thinking process starts from the perspective of a challenge in comparison to an idea for a startup in the lean startup process. This allows for extensive user research with elaborate qualitative research methods which the Lean startup lacks. Additionally, the design thinking process provides sophisticated methods to synthesize the insights from the user research [32].

Thus in the context of this thesis, the user-centered design thinking approach offers better qualitative methods to analyze the users needs and synthesize them to answer the research questions set out by the thesis as the study focuses more on the

challenges posed by enabling value-centric shopping patterns as opposed to business ideas with the user-centered approach proposed by the Lean Startup method.

The design thinking framework as shown in figure 6 is broadly categorized as understanding, exploring and materializing the idea. These categories are further split into empathize, define, ideate, prototype, test, and implement [6].

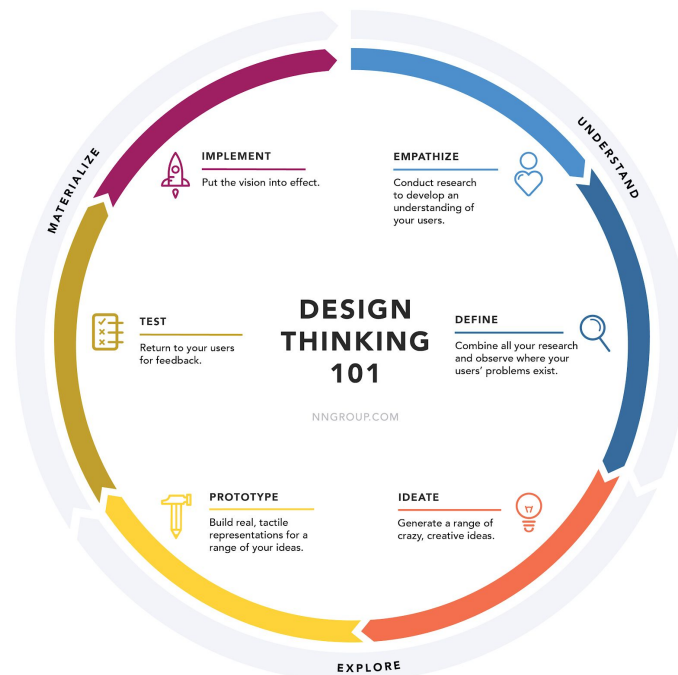


Fig 6: Design thinking process as defined by the Nielsen Norman group [6]

Design thinking is a user-centred process that starts with user data, creates design artefacts and addresses real and not imaginary user needs, and then tests those artefacts with real users [7].

2.3.1 Empathizing Stage

Initial user research is conducted through methods such as online surveys, fly-on-the-wall observations etc. The results of these are then used to gain in-depth knowledge on what the users say, do, think and feel. The goal of this being that the observations can then be mapped to truly empathize with the users and get the best possible understanding of their needs and underlying problems. The evaluation methods used for this phase in this thesis were online questionnaire, cognitive task analysis and personal inventory. These are described in detail in section 3.2.

2.3.2 Define Stage

The outcomes of the empathize stage are analyzed and synthesized to define the core problems are design requirements. These are defined as the needs of the user and not as the needs or wishes of the company. For example, we ask “How do we get consumers to eat nutritious food in order to thrive, be healthy and grow ” instead of “how do we increase food-product market share among consumers by 5%” [7]. The define-stage also builds up to the ideate stage by asking “how might we...” questions such as “how might we encourage consumers to purchase groceries in line with their goals that also involve the services provided by [the company]?”

2.3.3 Ideation Stage

In the ideation stage, a range of creative ideas are brainstormed to address the users’ needs identified in the Define phase. The design team is given total freedom and it is important to remember that no idea is too far fetched and that quantity of ideas is more important than quality. The advantage of this stage being that it explores multiple avenues for the same problem thus leading to innovative solutions [7].

2.3.4 Prototype

In this phase, a subset of the ideas are represented realistically. The goal of this stage is to analyze which parts of the ideas are feasible and which not. The feasibility and impact of the ideas are measured through feedback from users on the prototypes.

A prototype is characterized by a certain level of fidelity to the final product [8]. For example, interactions with sketches on paper are referred to as low fidelity paper-prototypes and clickable ones that look almost like the finished product would be high fidelity. The high fidelity ones would allow for higher degrees of interaction. In the context of this master thesis, a high fidelity prototype would be a mobile application that can be tested with a smartphone.

2.3.5 Test

The prototypes are given to the users for a usability test wherein they are asked to evaluate the designs. The feedback is used to analyse if the solution meets their needs and if it has improved their tasks in a way that it was intended to.

Traditionally, users tests would be conducted with evaluation methods such as the think-aloud study and semi-structured interviews but since this thesis was done during the covid-19 pandemic, where meeting people was difficult, an online approach for the usability testing was taken with the help of an online usability testing tool MAZE.

2.3.6 Implement

The designs are then put into effect. In the case of this study, this means to build the final mobile application which can be used by the consumers but the development of the application is beyond the scope of this thesis and will be covered in future work.

2.4 Usability Testing

The purpose of usability testing is to evaluate if particular users can perform particular tasks in particular contexts [27].

“The term usability testing is usually restricted to describing the evaluation of the usability of a system under controlled conditions”[27]. However, different organisations set up their usability tests in different ways. Usually there is a room where users are allowed to perform a set of actions and a separate room from which evaluators observe the action performed by the user [27].

The user tests are performed by defining a set of task scenarios that represent the critical characteristics of the tasks to be performed with the system [28]. These scenarios are typically used to make the user understand the real-world tasks and use the proposed system to solve the problem at hand, but they do not describe how to solve the problem. Thus the scenario contains information about a goal that the user has to reach, information about that goal and the context in which it takes place without describing how to reach that goal [27]. Thus the task of the user is to reach the goal by using the system.

In the context of this study, an online usability test was conducted. This meant that a link with the set of task scenarios was distributed to the participants, their answers were recorded and later analysed.

2.4.1 Cognitive Tasks

Cognitive tasks are those that require a person to mentally process information to organize knowledge and recall or retrieve information from memory to use it at a later time or transfer it to another system [31]. In the context of this thesis, cognitive task analysis methods are performed to understand the users decision points while purchasing products at retail grocery super markets. This has been described in detail in Section 4 - Methodology.

2.5 Mental models

By interacting with the environment, the artefacts of the system and all of its other stakeholders, people form internal mental models of the system [29].

A mental model can be easily defined as what the user believes or thinks they know about the system at hand [25]. It is often assumed that the users' thinking is closely related to reality as their predictions of the system are based on their mental models and they plan their future actions based on these. Thus a primary goal for designers is to make the user interface communicate with the system's basic nature well enough to form accurate mental models amongst the users [25].

The mental models presented by the users are usually not accurate but they are functional [29]. So a person through interaction with the system will continue to modify their model to be able to get an accurate result [29]

Thus, entering into the design process with the user's preconceived mental model to iteratively build a prototype, refine it and test it until getting an acceptable usability is the classical empirical approach used in defining the user flow of a system being designed [30].

In the context of the thesis, users' mental model on the features offered by the Consupedia Application is analysed to identify the user flow of the application proposed by this thesis.

Delimitations

Since the thesis was done in collaboration with Consupedia that was working towards developing a mobile application, only the option of designing for a mobile application was explored. Additionally, since this was done during a short time period, tests were performed by simulating actual scenarios through a prototype of the application. Actual implementation through the development of the app could not be done.

3. Background

3.1 Description of examined application

This section provides an overview of the original version of the consupedia application as of April 2020. This will be referred to in the Prototype development where the heuristic analysis of this application is done.

3.1.1 Search Function

This is the default page the users land upon opening the application. From this page, users can search for information on groceries, supermarkets or businesses that supply groceries. In the case of looking for information on grocery products, the search bar has a scan button to the right of the search bar as shown in figure 7 with which users can scan the barcode of a product for information.

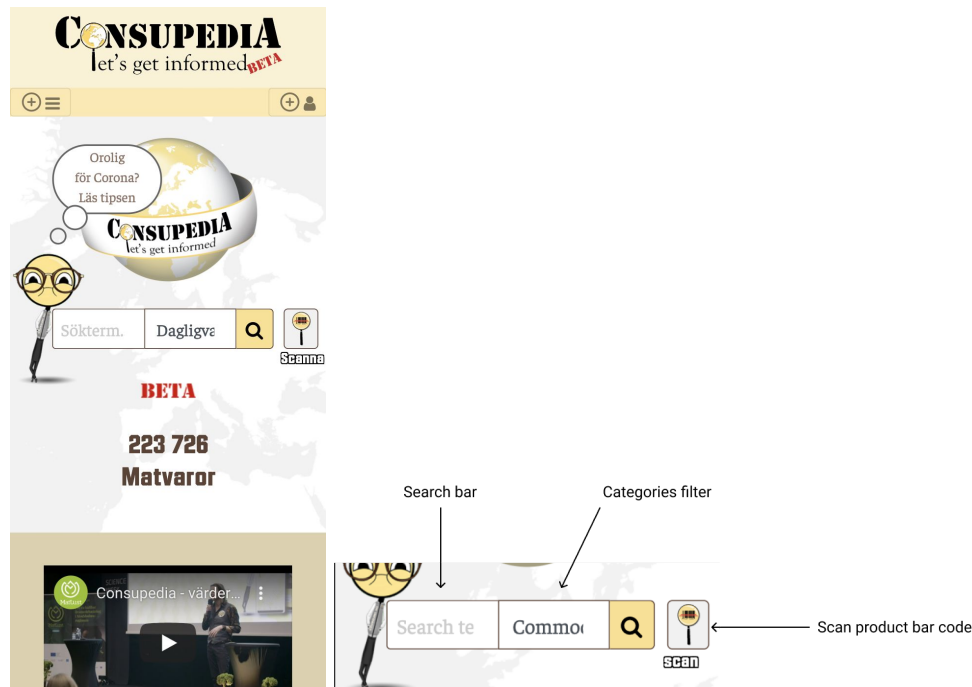


Fig 7: Search function on the Consupedia application screen

3.1.2 Personal dashboard

3.1.2.1 Overview Screen

Once the user logs in, the app navigates to the personal dashboard shown in figure 8 where the users can add or create shopping lists, record past purchases or tweak the settings of their account by navigating to the settings page described in section 3.2.2. Additionally, they can also create sub consumers or co consumers.

Sub consumers are those who belong to the same household but for using a different shopping list or shop at different times, for example, children or partner of the account holder. This is useful to allow for multiple users from the same house to shop simultaneously and create lists that do not overlap and allow these users to set separate goals for themselves.

Co-consumers are those (who also have a consupedia account) who are added to a public shared shopping list, for example before a party to inform guests (co-consumers) who can then be informed via the shared list on what to buy.

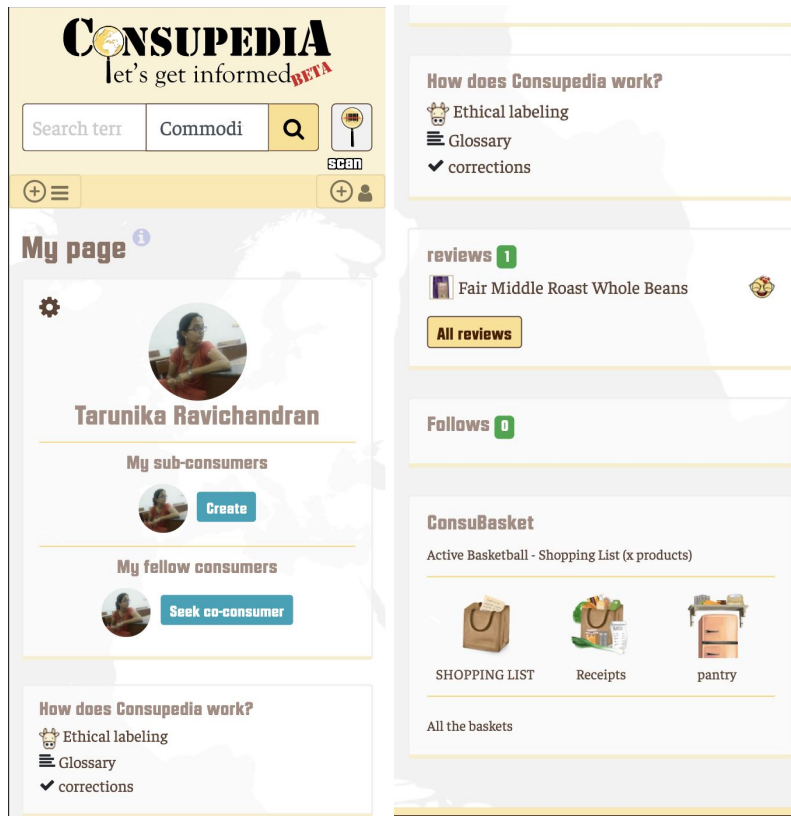


Fig 8: Landing page once user logs in to the application

3.1.2.2 Settings Screen

Upon navigation to the settings page shown in figure 9 from the overview page shown in figure 8, users can input their allergies and details. Importantly this page allows users to set the importance of values such as Health, Environment, Justice, Quality, Affordability for the products that they wish to purchase with the help of the sidebar shown in the middle screen of figure 9. Additionally, the user can also set allergens and transport distance of the products.

consumer Physics ⓘ

Weight Length

My allergies ⓘ

allergies

Allergy	Not serious	Serious
Lactose	<input checked="" type="radio"/>	<input type="radio"/>

Add an allergy ...

Blacklisted ingredients ⓘ

Look up and add ingredients

Type of consumer ⓘ

☐ Public consumer

☒ Private consumer

Your ConsuValues ⓘ

Health Environment Justice qQUALITY

25 % 87 % 25 % 63 % 75 %

Maximum transport distance ⓘ

4838 km

Your ConsuValues ⓘ

Health Here you can specify what is important to you when you are facing a purchase. qQUALITY

Figure 9: Setting page

3.1.2.3 Creating a shopping list

From the overview page, users can also create a shopping list. To do this, as shown in figure 10 they must first navigate to the create shopping list page, then give a name to the list and then create the list by clicking on 'create Consubasket'.

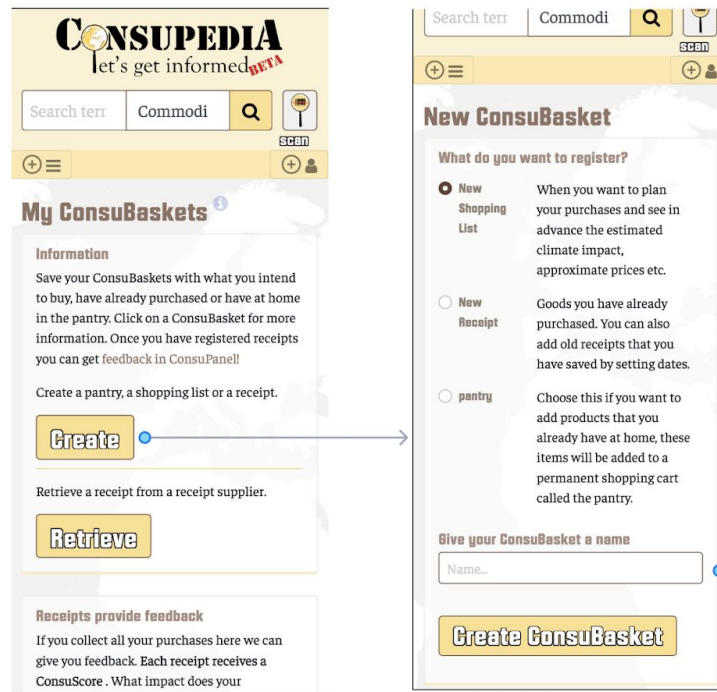


Fig 10 : User flow to create a new shopping list

Adding items to the shopping list

To add items to the shopping list, users have to search for products and add them to the list by clicking 'Save'. Users can create different lists and an overview of the lists can be seen at the bottom upon scrolling on the shopping lists page. This has been shown in figure 11.

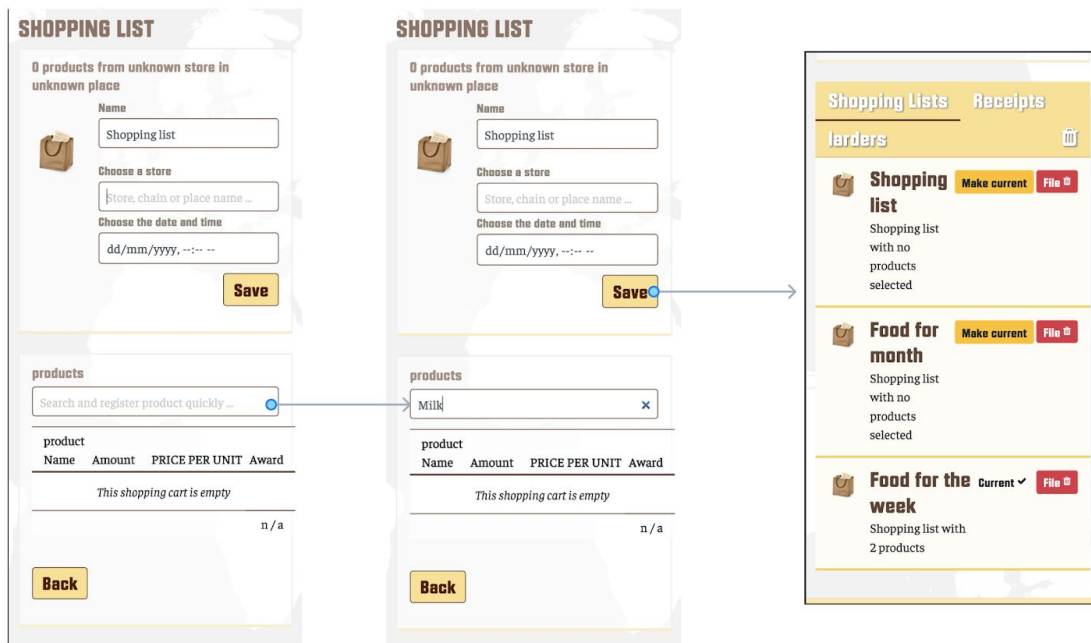


Fig 11: User flow to add items to a shopping list

3.1.3 Product information

Upon clicking the search results, users navigate to the product information page as shown in figure 12.

Information on each of the values of Health, environment etc can be seen upon clicking on the value of interest.



Fig 12: Product information screen

3.3.1 Information on Values

Upon clicking on the value of interest, users are shown information pertaining to those values as shown in Figure 13



Fig 13: Health and environment information on the product

3.2 State-of-the-art

This section describes the state of the art in using digital interventions to bring about a behaviour change for more sustainable food consumptions.

Hedin et al. performed a literature review which analysed the status of current scientific knowledge of digital behaviour change intervention for more sustainable food practices and explored the most significant results from the field. The study included papers at the intersection of ecological sustainability and food consumption behaviours. The review evaluates various different digital touch points that provide an intervention for more sustainable food consumption. The study evaluates 15 literature papers based on the behaviour change wheel and its frameworks. Out of them, “12 had the sustainability goal of reducing food waste, one had the goal of improving disposal of cooking oil, one had the goal of reducing energy used for cooking food and, one had the goal of increasing organic food purchases” [3]

The papers reviewed in the study were compared based on their sustainability goal, aim/objectives, target behaviour digital interventions and intervention results [3].

The results of the study suggested that the behaviour change techniques that stood out, were feedback and monitoring which accounted for 25% of the interventions as compared to 16% for sedentary behaviour and 13% for gamified health applications[3]. Furthermore, the study connects the use of feedback and monitoring techniques for achieving behaviour change to control theory [34].

It has been suggested by control theory that goal setting combined with feedback and monitoring is effective in achieving a behavior change. Thus the study notes that “of all BCTs coded, the goals and planning category was only coded four times (1%), which can be compared to 28% for the study on sedentary behaviour and 10% for the study on gamified health apps. **This could indicate that goals and planning is a theory-based type of intervention with high potential that has not yet been explored within the area of digital behaviour change interventions to change sustainable food consumption practices.**”

This thesis explores the underexplored goals and planning category to bring about a behaviour change with a digital intervention. Thus the final application proposed would fall in the 1% category with the aim explore and propose solution in an area that has high potential in the context of bringing about a sustainable and healthy food consumption pattern

4. Methodology

In this section the methods used in the five stages of the design thinking process have been described. A flowchart representing the methods used and their interaction is represented in figure 14.

The methods used in each stage are described in detail for the Empathise Stage in section 4.1, for the Define Stage in section 4.2, for the Ideate Stage in section 4.3, for the Prototype Stage in section 4.4 and for the Testing Stage in section 4.5.

The choice of methods for each stage were based on the objectives of the stage, the objectives for each stage and how the chosen method reaches the objective is summarized in table 3.

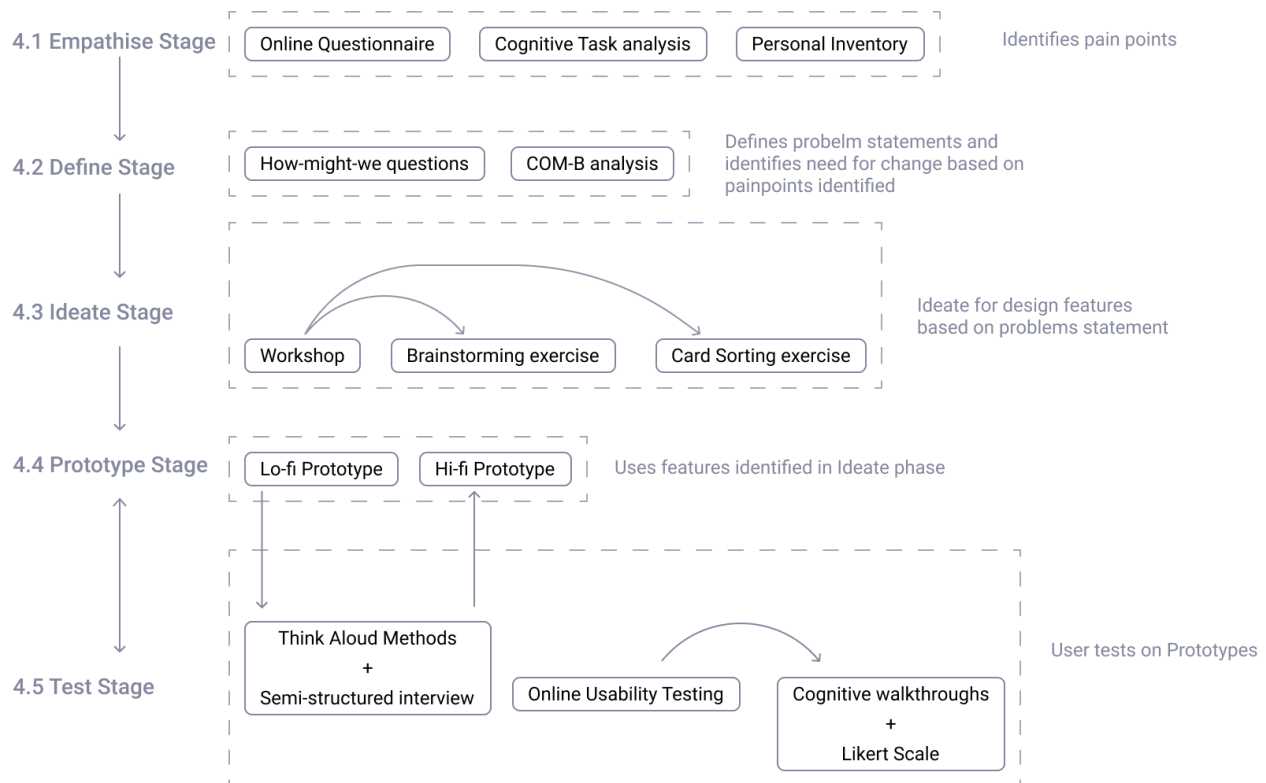


Fig 14: A flowchart representing the five stages of the design thinking process and the methods used in each stage

Stage	Objective	Method	How does it meet the objective?
Empathise	Understand current knowledge and what they lack	Online questionnaire	Responses elicit what the user knows and feels
	Understand users current decisions and pain points in making them	Cognitive task analysis	Responses elicit what the user thinks, feels and does
	Understand users	Personal Inventory	Responses elicit

	current behaviour and patterns to identify unmet needs		what the user does
Define	Define pain points in terms of the COM-B components to ideate for change	COM-B analysis	Behavioural diagnosis which identifies what needs to change; to be used for ideation
	Prepare for ideation by posing the components that need change as questions	How-might-we questions	Questions to be addressed for solutions in the ideate phase are defined
Ideate	Ideate on problems defined for possible solutions	Workshop	
		Brainstorming exercise	Identifies a long list of design features that could be used for the prototype developed
		Card Sorting exercise	Identifies the mental model for the users of the proposed solution
Prototype	Prototype based on feasible and usable design features identified	Lo -Fi Prototype	Quick and easy way to identify feasible and usable design features
	Prototype based on feedback from lo-fi prototype	Hi-Fi Prototype	Prototype that matches users needs
Test	Feedback on Lo-Fi prototype	Think-aloud method	Reveals opinions on the initial prototype
		Semi-structured interview	Collects detailed feedback for next iteration
	Answering research	Online usability test	

	questions	Cognitive walkthrough	Success rate and responses to task scenarios suggest results to research questions posed
		Likert Scale	Elicits how easy the application is to understand and how easy it was comprehend the information shown in the application

Table 3: Methods, their objectives and how they meet the objectives

Since this thesis was conducted during the global COVID-19 pandemic, finding participants was difficult and thus evaluations were carried out with a limited number participants for the different tasks at each stage.

4.1 Stage 1: Empathize

4.1.1 Online Questionnaire

An online questionnaire is used when a researcher wants a large number of respondents for the research. Depending on the objective of the study, these usually contain both multiple-choice questions and open-ended ones to record the opinions of the participants. The questionnaire is usually sent to the user group identified to ensure that the results can be generalized to that user group. The responses usually reveal what the user has to say and what they think about the problem at hand.[13]

For this study, an online questionnaire was designed to gather information about what the users think and feel when it comes to value-centric grocery shopping. It probed on the importance of the values of nutrition, sustainability, fairness in products and price of the groceries. Questions also included the problems that consumers faced when they wanted to shop according to their values/goals. Participants for the survey were selected on the basis that they shop at Swedish retail supermarkets. The reason for this choice was because the study concentrated on consumers of retail supermarkets in Sweden. There were 76 participants for this study who were equally distributed between male and female and in the range of ages between 18-70. Most of the participants were Swedish, educated and familiar with using mobile applications. A detailed list of questions asked can be found in Appendix A.

4.1.2 Cognitive task analysis

A cognitive task analysis is used to list and summarize all of the user's sensory inputs decisions and actions [21]

This is useful in understanding the user's perceptual, attentional and informational needs. Insights from this process can be used to identify bottlenecks in the system that is being designed [21]

The participants for this study were bachelor students of KTH who were mandated to participate in a master thesis study and it was ensured that those chosen for this task shop at Swedish retail super markets. For this study, these participants were asked to list and summarize their sensory inputs, actions and decision points when they shop for groceries. This meant that the participants of this study were requested to audio-record their shopping process and elaborate on the reasons for a product they chose to buy. There were six participants for this task all who were all Swedish and bachelor students of technology at KTH Royal Institute of Technology between the ages of 18-33; two of whom were male and four female. The participants were requested to following the instructions below:

Please switch on any audio recording app on your phone when you enter the grocery store/sit down to shop online and follow the instructions below

- 1. Start talking into the recording about what you feel as you walk through the store*
- 2. Each time you pick up an item, please record the item you picked up its brand, its quantity and state the reasons for the choice. If you feel there are multiple reasons for the choice, please state them all.*
- 3. Remember to talk your mind as freely as you like*

Once finished, please upload the recording to this link.

A detailed list of instructions for the task can be found in Appendix A. In total there were six entries from the six participants of this study.

4.1.3 Personal Inventory

Participants are asked to document their belongings as a way of cataloguing evidence of their lifestyles. This method is useful in revealing people's activities, perceptions and values as well as identify patterns among them [21]

The participants for this study were bachelor students of KTH who were mandated to participate in a master thesis study and it was ensured that those chosen for this task

shop at Swedish retail super markets. For this study, participants, same as those of the cognitive task analysis, were asked to document their current inventory of all items bought from the grocery store. They were given an excel sheet, shown in Appendix A, with categories of what was typically found in a grocery store. The categories were further subdivided into brand and type to make observations on what the user actually does as compared to their thoughts and feelings.

There were six participants for this task who were all Swedish and bachelor students of technology at KTH Royal Institute of Technology between the ages of 18-33; two of whom were male and four female.

4.1.4 Empathy map

An empathy map is used to understand what we know about a particular type of user. It externalizes knowledge about users in order to (1) create a shared understanding of user needs; (2) aid in decision making [22].

The empathy map would consist of four quadrants based on what the user says, thinks, does and feels. This helps understand the user better by categorizing knowledge about the user in one place. This could also identify if there are any gaps in user research conducted. The empathy map would also illustrate user attitudes and behaviours [22].

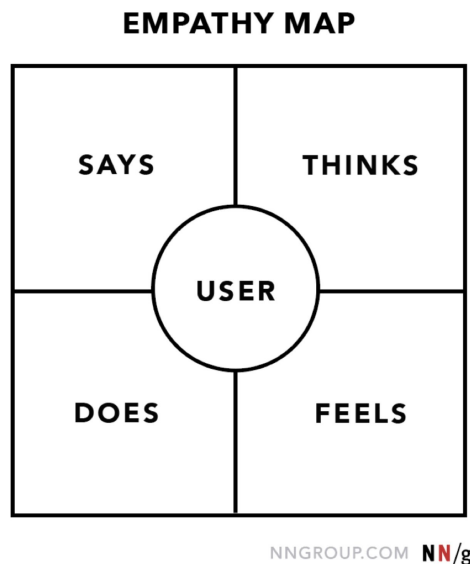


Fig 15: Empathy map[22]

In this study, the empathy map, shown in the appendix was used to illustrate the users' attitudes and behaviours towards value-centric shopping. It was used to identify values that were most important to the participants while shopping for groceries. The empathy map was created only for those participants that took part in the online questionnaire and cognitive analysis and personal inventory. These participants were the same as

those who took part in the cognitive task analysis and personal inventory whose responses on the online questionnaire were identified for the empathy map. They were six participants who were all Swedish and bachelor students of technology at KTH Royal Institute of Technology between the ages of 18-33; two of whom were male and four female.

4.2 Stage 2: Define

4.2.2 COM-B analysis

To define the problem statement for ideation, the pain points identified in the Empathise stage as outcomes of the user research, are defined as capabilities, opportunities or motivations that need to be changed, that is, increased or decreased to achieve the target behaviour. This is done with a behavioural diagnosis 'worksheet 4 - Identify what needs to change' suggested in the Behaviour Change Wheel (BCW) [3]. This diagnosis categorizes the users' pain points and users' needs identified in the empathise phase based on components of the COM-B analysis. The worksheet is detailed in the outcomes of the Define phase in section 5.2.1.

4.2.1 How-might-we questions

The outcomes of the empathize phase are used to get insights which are arranged as how-might-we questions to pinpoint the user's needs and highlight the opportunities for innovation [6]

In the context of this thesis, this phase was used to develop how-might-we questions based on the behavioural diagnosis of the COM-B components to ideate on features that can bring about the necessary change to achieve the target behaviour. These questions could be framed like: "how might we encourage consumers to purchase groceries in line with their goals that also involve the services provided by Consupedia (company)?" The outcomes defining all the How-might-we questions which are then used in the ideate phase are presented in section 5.2.2.

4.3 Stage 3: Ideate

4.3.1 Focus Group

A workshop is typically conducted to test existing ideas or brainstorm new ideas [8] It is generally used to collect qualitative data from multiple participants simultaneously. Well-designed focus groups usually last between 1 and 2 hours and consist of between 6 and 12 participants. [8] However, it is also possible to conduct “mini-focus groups” of 3 to 4 participants when the participants have specialized knowledge or experience [8].

For this study, the focus group was used to brainstorm new ideas for the final system. A pilot test of the tasks for the focus group was conducted with two participants both of whom were female master students at KTH Royal Institute of Technology. One Swedish and the other an international student. Based on feedback from the pilot test, the final tasks for the focus group were designed and conducted with six bachelor students from KTH Royal Institute of Technology who were Swedish; two male and four female. If the Covid-19 global pandemic situation was not prevalent, there would have been more focus groups and participants.

The workshop included two tasks. It was kicked off with the brainstorming session followed by the card sorting exercise.

4.3.1.1 Brainstorming session

Participants are asked to brainstorm three value tensions that the system or application may engage. For each value tension, participants are requested to identify one or more design features that favour one of the values over the other [23]

For this study, participants were given ten minutes each to identify value tensions in the grocery shopping process. It was explained beforehand that the values engaged by the system were Nutrition, Carbon footprint, Water Footprint and Fairness in Production. Once the participants identified value tensions they were given another ten minutes to give ideas on one or more design features that favour one value over the others. Participants were reminded that the feasibility of implementing the ideas was not important and that quantity supersedes quality. Each participant then generated 10-12 ideas which were then discussed. This allowed for engagement and free communication between the participants. This led to some more new ideas being generated. This task was useful to identify design features that users would benefit from for a value-centric grocery shopping experience.

4.3.1.2 Card Sorting

The participants are given a set of cards with design attributes functions or features and they are asked to arrange them in an order that makes most sense to them [21]. This is done to expose the users' mental model of the system and their expectations and priorities about the intended function [21].

In this study, this task was used to uncover the mental model and user flow for the final app that was being designed. The cards given to the participants included tasks such as "checking information while shopping", "Sharing information with friends" "checking visualisation for adherence to goals" etc. A detailed list of all design features is mentioned in appendix A

4.4 Stage 4: Prototype

"Prototypes can take various forms from renderings and diagrams on paper, cardboard and/or foam representations (usually with limited or non-functioning controls and displays), touch screen simulations of interface panels etc., three-dimensional simulators, to virtual reality environments. The attribute which distinguishes these prototypes is their relative" fidelity or faithfulness in reproducing the characteristics of the finished product" [8]

The design process for a prototype is as suggested by Hall[8]:

1. Select the lowest level of fidelity fit for the product being designed
2. Select a small representative of target users as subjects
3. Select representative tasks to perform
4. Select appropriate usability criteria to measure
5. Run user trials in a scientific method
6. Redesign with a higher level of fidelity

Repeat process as necessary

For this study, prototypes were created based on observations and analysis of the empathize, define, ideate phase and the analysis of the consupedia application at the time of writing this thesis. One low fidelity prototype using a digital tablet and pencil was created for initial feedback based on which two iterations of high fidelity prototypes were created using Figma, a desktop application.

Although there are multiple methods to measure usability and receive feedback on prototypes, for this study, the initial prototype used a think-aloud method and

semi-structured interviews to collect feedback from student colleagues and peers who shop at Swedish supermarkets.

The feedback was received from three participants who were all international students living in Sweden. The choice of participants was restricted mainly due to the COVID-19 global pandemic.

The high fidelity prototype was tested with cognitive walkthroughs via an online usability testing tool, MAZE.

4.5 Stage 5: Test

4.5.1 Usability Testing

The following methods were used for the usability testing of the final prototype designed for this study.

4.5.1.1 Heuristic Evaluation

A Heuristic analysis is conducted to understand and analyse the design features and decisions of an existing interface for the system/application.

To conduct the heuristic analysis, a list of usability heuristics and a description of the interface being evaluated is first made. Based on this, evaluators are free to inspect any part of the interface guided by these heuristics. The evaluations are then documented as problems with the interface as they violate the chosen list of usability heuristics. The documentation also provides enough context to understand the problem in the future [20]

A list of heuristics that was used for evaluation of the Consupedia's (the company) mobile application interface was those defined by Nielsen and Molich[26]:

Heuristic	Definition
Simple and Natural Dialogue	Do not show any irrelevant or rarely used information
Speak the user's language	Use words or concepts from user's world and do not use any system-specific terms
Minimise user memory load	Don't make the user remember things from one action to the next. Leave information on the screen until it is not needed.

Be consistent	Users should be able to learn an action in one part of the system and be able to apply it again to get similar results
Provide Feedback	Let users know what is the effect of their action on the system
Provide clearly marked exits	If users get into a part of the system that they are not interested in, they should always be able to get out quickly without damaging anything
Provide shortcuts	Shortcuts can help experienced users avoid lengthy dialogues that they don't need
Good error messages	Good error messages lets the user know if they made a mistake
Prevent errors	Ensure that the user does not perform an action that they need not perform

Table 4: Usability heuristics [26]

In the context of this thesis, a heuristic evaluation according to the nine usability heuristics defined by Norman and Molich as shown in Table 4 is used for Consupedia's (the company's) mobile application. The analysis is conducted to identify if any design features used by their current application could be borrowed for the final application design proposed by this thesis.

4.5.1.2 Cognitive walkthrough

A cognitive walkthrough is conducted to understand people's thoughts and actions while using an interface for the first time [19].

To conduct a cognitive walkthrough, a high fidelity prototype is tested with the target user group. Tasks that represent user actions with the system are detailed to the test subjects with a believable story about each action the user has to take to complete defined tasks. The story is made believable through feedback and prompts given by the prototype [19].

In the case of this thesis, a cognitive walkthrough was done through an online usability testing tool called Maze Design. A list of the tasks and questions asked in the test is

detailed in the appendix. The link to this test was posted on Facebook and distributed to the participants of the workshop as well and had 34 respondents. The responses recorded were mainly from Swedish people who were both male and female.

Traditional methods of using think-aloud methods for the analysis of a cognitive walkthrough were not possible as this thesis was conducted during the global COVID-19 pandemic where meeting people was not possible.

4.5.1.3 Open-ended questions and close-ended questions

Open ended questions allow respondents to give a free form answer and Close-ended questions have a specific set of answers such as “Yes” or “No” or other limited set of possibilities to answer from (such as: A, B, C, or All of the Above) [24]

Open-ended questions help find behaviours or concerns that the researcher knew nothing about. When test subjects are asked to explain their actions or thoughts it could reveal surprising mental models [25], problem-solving strategies, hopes and fears. [24]

In the context of this thesis, open-ended questions were used to record responses and emotions on design features explored by the final prototype. Close-ended questions were used to poll which of the presented outcomes were preferred by the test subjects. Additionally, Likert scales [12] were used to get the general opinion about the final application.

Likert Scales

A Likert scale is commonly used to measure attitudes towards a system. This is done by providing the test subjects a range of responses to a given question or statement. Usually, there are 5 categories of response, from (for example) 1 ¼ strongly disagree to 5 ¼ strongly agree, but there are arguments in favour of scales with 7 or with an even number of response categories [12]

In this thesis, Likert scales were used to record how well the test subject understood the information that is presented to them via the prototype of the application.

4.5.1.4 Thematic analysis

Thematic analysis is carried out to analyse the answers to the open-ended questions in the test. Maguire and B. Delahunt [11] state that “Thematic analysis is the process of identifying patterns or themes within qualitative data”. According to them, the following steps should be carried out for thematic analysis:

- 1) Understand and read the data at hand

- 2) Code the data by organizing them in a systematic way
- 3) Look for patterns that answer the research question at hand
- 4) Review and ensure that the identified patterns are relevant to the research question
- 5) Define themes, sub-themes and relationships between them
- 6) Describe the results

Different iterations of these steps in different orders are also possible.

In the context of this thesis, thematic analysis was used to analyse the responses recorded in the open-ended questions to answer the research questions set out by this study.

Ethics and Privacy

Ethical concerns and privacy were taken into account for this study. Since participants of the study recorded their personal inventory of groceries and choices with a lot of detail, the data collected was sensitive. It was ensured that participants' anonymity was maintained. Data collected was used only to answer the research questions set out by this study and it was not shared with any third party including Consupedia, with whom this thesis was done in collaboration with.

5. Prototype Development

This section discusses the results of the evaluations carried out in the empathize, define and ideate and prototype phases of the design thinking process followed by the prototypes developed. Section 5.1 outlines the outcomes of the empathize phase which are used in the define phase in Section 5.2. The outcomes of the define phase are then used in the ideate phase in Section 5.3. Design features identified as outcomes of the ideate phase are then used for the Prototype phase in Section 5.4.

5.1 Empathize

The empathize phase was mainly used to understand the problem and identify users' needs and pain points. This was done through an online questionnaire, cognitive task analysis and personal inventory. The outcomes of these evaluation methods are described in this section. The pain points identified based on these outcomes are presented in Table 3 in the 'Summary' of this section.

Participants

The online questionnaire had 76 participants all of whom were Swedish. The participants were equally distributed between male and female belonging to the ages of 18 to 70.

The cognitive task analysis and personal inventory had six participants all of whom were Swedish and pursuing their bachelor studies at KTH Royal Institute of Technology and were between the ages of 18-33; two male and four female.

5.1.1 Outcomes of the online questionnaire

The following observations were made on the shopping habits of the respondents:

1. **76%** of the respondents **planned their shopping in advance**
2. Almost **all respondents used grocery lists** either via an app on pen and paper to plan their shopping
3. **56%** of the people **cared about values** such as nutrition, carbon footprint/water footprint or ethical production of the product.
4. **Apart from affordability, choice of brand** was dependent on **ethical production and sustainability values** of the food purchased.
5. **90.8%** of the participants feel that **sustainable shopping is important** to them
6. **72.4%** of the respondents reported that **finding product information** was **difficult or missing**
7. **36%** of the participants **don't buy** certain products **that lack information** on them as it is too difficult to find.
8. For a majority of the participants, other than price, the major reason they are **not able to shop sustainably** is that they **lack information** and **knowledge** on what products match what they are looking for.
9. **40%** of the people were **not sure about the labels on products** and their meaning. These also **expressed the need for explanations** on the various certificates and **labels** used by the supermarkets and brands

From this, the **first pain point** identified was that there was a **lack of information** on products for the different values of health, environmental impact and a **lack of knowledge** among consumers on the various labels used and its importance.

5.1.2 Outcomes of cognitive task analysis

Based on analysis of the recordings received from six participants, it was observed that the participants **chose products and brands based on their cooking plans, price of the item and ease of finding the product** they are looking for. When the **price was not an issue**, one participant who was shopping online used the assistance of Google to check for most **nutritious options**.

An observation that was common to **all participants** was that their **choices depended on multiple factors** such as price, nutrition value, allergens and taste of the product. The participants always **made a tradeoff** between the various factors **based on their previous experience** of using the product, **its availability or the quantity offered by the brand**.

From this it can be observed that most participants **planned their grocery shopping in advance** based on cooking plans, implying that **grocery lists were made** based on these. However, **they lack information** on values of products in this phase and thus the choice of products often depended on the trade-off between previous experiences and price.

5.1.3 Observations from personal inventory

Entries made in the personal inventory were used to make the empathy map to see what the users actually do.

Two of the participants were shopping at a large supermarket chain in Sweden - ICA, one online and the other at the physical store. Both these participants **chose** most items in the brand offered by the supermarket - ICA as it was the **cheapest choice**.

Participant number 3 was **eating plant-based food** and **inventory** of that participant was **dominated by brands that offer vegan and plant-based products**.

A **common pattern** identified amongst all participants was that they were **buying** items mostly **based on price** unless they had **dietary restrictions**. When it came to products that were not food, three out of the four participants chose the brand of the store they shop in order to choose the least expensive option.

The entries in the inventory sheet were also discussed in the focus group session where participants explained that **although their choices were driven by price, quality of the brand and alternatives were often considered based on nutrition value** or other **ethical factors** that each participant **considered important**. A consistent remark from the participants was that, if the **information was available at a glance easily and**

alternatives that **do not require a huge price trade-off** were presented, their **choices** would probably **change**.

This behaviour of changing a brand for a product based on information on the nutrition value was observed in the cognitive analysis task with the participant that was shopping online.

A **common pattern** observed from these tasks was that **participants change their product choice** if **product information on the values that concern them was easily available** and the **alternatives presented were not too expensive for them**.

Summary

This section summarises the pain points identified as outcomes of the empathise phase. This is shown in Table 5.

These pain points are used in the define phase to define problem statements and identify what needs to change.

Method	User needs / Pain-Points Identified
Online Questionnaire	Lack of information on Products
	Lack on knowledge on Labels
Cognitive analysis	Making grocery lists based on cooking plans
	Lacking information while making grocery lists
Personal Inventory	Choice of products dominated by dietary restrictions or Price
	Values of Health, Environmental impact or Fairness in Production often clash with affordability

Table 5: User needs and pain points identified from each method

5.2 Define

In the Define phase, the problems, pain points and understanding of the target user group's capabilities, opportunities and motivations identified from the empathize phase were used to perform the COM-B analysis. The outcomes of which were used to make design decisions that would help achieve the target behaviour of value-centric shopping. Additionally, the outcomes of the COM-B analysis was used in the construction of "how might we" questions that would lead to the ideate phase of the prototype development process.

5.2.1 Using the COM-B model to define design features

Behavioural diagnosis based on initial user research was conducted to identify what needs to change in order to reach the target behaviour. This was carried out in accordance with the worksheet suggested in BCW [3]. The outcomes of this are displayed in Table 6.

COM-B Components	What needs to change for the target behaviour to occur?	Is there a need for change
Physical capability	N/A	N/A
Psychological capability	Have the necessary information to choose the right product to understand impact of choice	Change needed as consumers lack information; Verified by the outcomes of the online questionnaire
Physical opportunity	Have access to smartphones and record grocery shopping data	Most people own a smartphone but change is needed for people to record their shopping data
	Have the availability of multiple brands with different estimations for values of nutrition, carbon footprint, water footprint and fairness in production	No need for change as supermarkets offer a great variety of products
Social Opportunity	Socially accepted mobile application that tracks	Change needed as consumers need a tool to

	shopping patterns against pre-set goals by the users	set said goals and a platform to discuss patterns as it normally does not come up in conversation
Reflective motivation	Intention to shop for products with low impact on environment or high nutritional value or produced with good labour condition	No Change needed as outcomes of online questionnaire shows that 90% of the people want to shop ecologically/ethically.
	Believing that consistently shopping according to values will set a good shopping pattern in line with set goals	Change needed as tools to easily track patterns and inform the user on benefits of shopping according to goals is lacking
Automatic motivation	Seeing goals and shopping patterns match thereby reducing the impact on the climate and/or contributing to social justice and/or good health	Change needed to establish a routine and form habits

Table 6: COM-B behavioural diagnosis worksheet

Based on the behavioural diagnosis, it can be seen that there is a need for change in the physiological capability, social opportunity and the reflective and automatic motivation. To bring about the changes in the factors for each component of the COM-B model identified for change in the behavioral diagnosis to reach the target behaviour, they are first defined as how-might-we questions to be able to address them and ideate for solutions in the next phase of the design thinking process - the Ideate Phase.

5.2.2 How-might-we questions

The how-might-we questions are used to define how might we increase [the component of the behavioral diagnosis] that needs to change based on what needs to change

1. How might we favour one value over another, for example fairness in production over price or Nutrition over fairness in production? (To increase physical opportunity and psychological capability)

2. How might we provide all the necessary information at a glance while highlighting personal goals? (To increase psychological capability)
3. How might we provide an overview of shopping patterns to create an impact on shopping habits? (To increase social opportunity)
4. How might we encourage consistently shopping according to personal goals to reduce impact on the environment and negative impacts on health? (To increase Reflective and automatic motivation)

Summary

The components of the COM-B model that need to change to bring about the target behaviour are defined by the How-might-we questions. The questions were posed as tasks/activities to the participants in a workshop in the next phase of the design thinking process - The Ideate Phase to ideate for possible solutions in order to address the problems identified. In summary, these questions were addressed by the evaluation methods used in the Ideate phase to identify design features that helped in making design decisions.

5.3 Ideate

In the idea phase of the design process, the outcomes of the Define phase were used for brainstorming sessions to come up with innovative design features. This was done by conducting a focus group online via Zoom. The focus group had two tasks, a brainstorming session followed by a card sorting exercise. The card sorting exercise led to defining the information flow and user flow for the prototype design proposed by this thesis.

Participants

The focus group had six participants all of whom were Swedish and pursuing their bachelor studies at KTH Royal Institute of Technology and were between the ages of 18-33; two male and four female.

5.3.1 Outcomes from Focus group:

5.3.1.1 Brainstorming session

The first part of the session required participants to identify value tensions in the grocery shopping process, for example price(affordability) often conflicts with environmental

values and fairness in production. The list of identified value tensions can be found in appendix A.

The second part of the session was to brainstorm design features that would help bring a trade-off between the value tension identified.

Of the six participants, four had the **idea to show a list of products** available the supermarket **ordered from best option to worst option in accordance with their goals**. The **idea** was that users could see this **list of all brands offering the product ordered/sorted** in a way that **the brand that best fit their goals** was at the **top of the list** and the **worst at the bottom**. This, they explained, **would help** them **make a trade-off between values such as price vs fairness in production to pick the second-best alternative** if they needed to, **instead of picking a brand that does not match with any of their goals**. This **list** would thus help them with making **informed choices at a quick glance**.

Many of the **other features discussed** in the brainstorming session were involved with the **planning phase of the shopping experience**. Four of the participants wanted to see product information and adherence to goals while making a shopping list.

Another idea that came up during this session was to have a **feature that analyzed bills** and receipts from the supermarket by **taking a picture of the receipt, after their purchase**. It was added that the **data collected** from these receipts along with the data on their ideal estimations for their goals on nutrition, fairness in production etc. **could be used for a visualization**. This would thus help in getting an overview for the consumers on whether they actually shopped in accordance with their goals and plans. This **overview would help in maintaining a history of purchase patterns to see over time** how well the user has been **sticking to their goals**.

5.3.1.2 Card sorting

Participants were asked to place the cards which mentioned design features in a way that makes the most sense to them. Red stickers were given for features that they thought were not useful. The design features on the cards are based on features offered by Consupedia at the time of writing this thesis. A common model amongst all participants was looking for information while adding items to their shopping list and checking if they reached their goals after their shopping trip or before they started planning for their new shopping trip. Many participants found features such as sharing information with friends and comments on products not useful.

An example of the outcome of the card sorting exercise can be seen in Figure 16

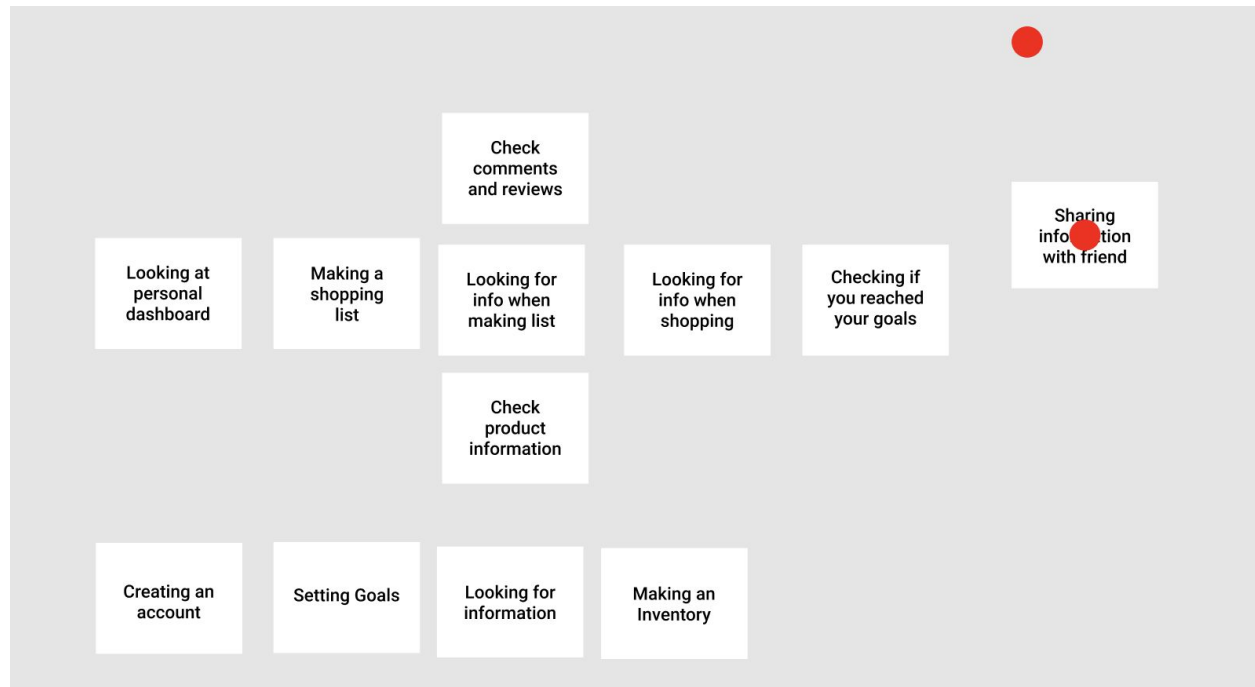


Fig 16: Card sorting exercise

Summary

To summarize the outcomes of the brainstorming exercise, participants wanted the application to present a list of products from best to worst based on their importance for the values of nutrition, environmental impact and fairness in production for all brands offering a product.

Additionally they also wanted a visualization of the estimations for the various values against their goals for chosen products. If the product did not match their goals, participants wanted to see a list of other brands offering the product and to be able to compare them.

The card sorting exercise revealed the mental model of the application amongst the participants which is shown in Figure 17.

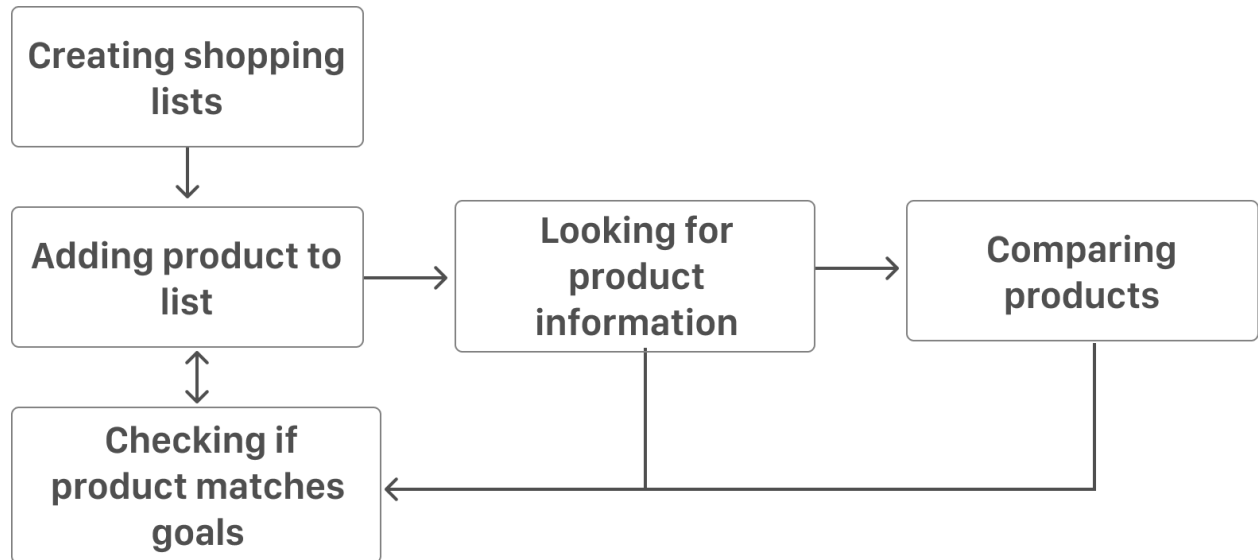


Figure 17: Mental model revealing information flow of the application

5.4 Prototype

The prototype phase uses the design features and design decisions identified in the ideate phase of the design process. Additionally, since the application design also depends on the Consupedia's mobile application (Please refer to the background section for a detailed description of the Consupedia application and its features) a heuristic analysis was performed to identify if any design features could be borrowed from it.

5.4.1 Heuristic Evaluation

Heuristic evaluation was carried out according to the nine principles given by Normal and Molich described in section 4.5.1.1

Simple and Natural Dialogue

Both the search results and the product information page show information that is not used and not relevant. The icons used in the search results use dimmed and not dimmed versions to inform the user about the labels on the product but the contrast is not high enough and thus making the information irrelevant and confusing. This is shown in fig. 18



Fig 18: Product information screen

Speak the user's language

The application uses unfamiliar terms such as co-consumer, sub consumer which causes confusion. Additionally there is no feedback on the language used against the

actions for these subsections of the page. This is shown in Figure 19.



Fig 19: Home page after logging in

Terminology used in the application such as Consuvalue, Consupinions and info are confusing as the user does not know what each means. Similarly it is not apparent to the user, the difference between info and consuvalue as they both seem to display information on the product. This is shown in figure 20.

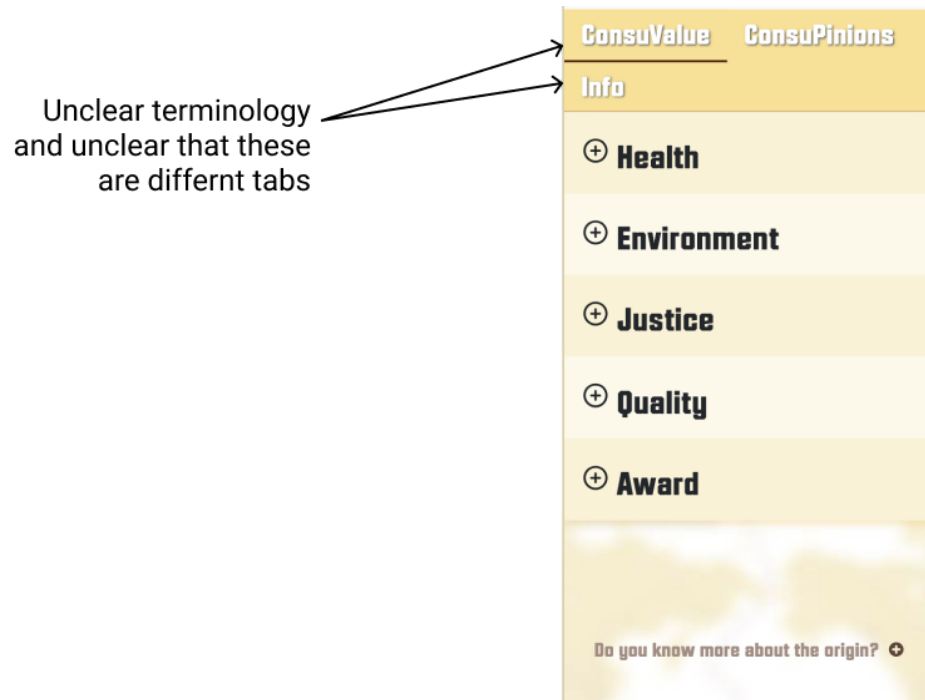


Fig 20: Product information screen

Be consistent, Provide shortcuts

Information is available on tap of icons at all screens of the application and similarly shortcuts such as labels are used for quick overview for experienced users shown in figure 21.



Fig 21: Screens that show information on tap about system functionality

Provide clearly marked exits

None of the screens/pages in the application have a back button or an easy way to go back to the previous action that the user was performing, except on the grocery list page, where the back button does not take the user back to the overview page.

Good error messages

There are no error messages that appear for wrong actions, making it difficult for the user to know if performed a wrong action. As shown in figure 22 while the user tries to add items to the list, if he/she taps save then a new list is created instead of adding the product to the existing list.

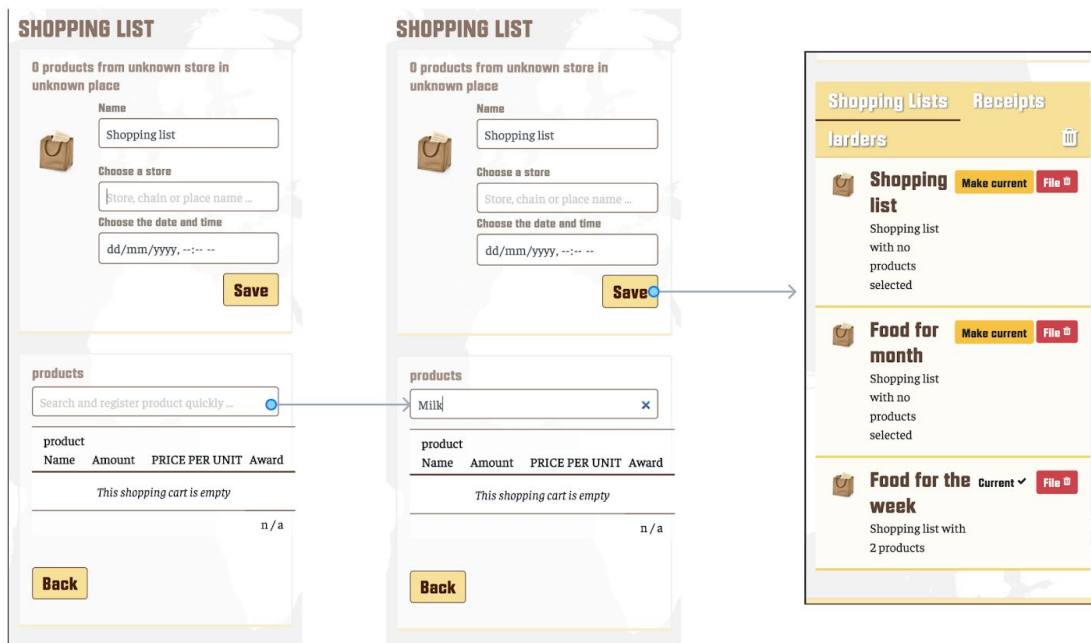


Figure 22: Creating a shopping list

Prevent Errors

When a shopping list is created, the user is not shown any instruction that the basket must have a name. Only when the user tries to create a basket as shown in fig. 23 an error message is thrown.

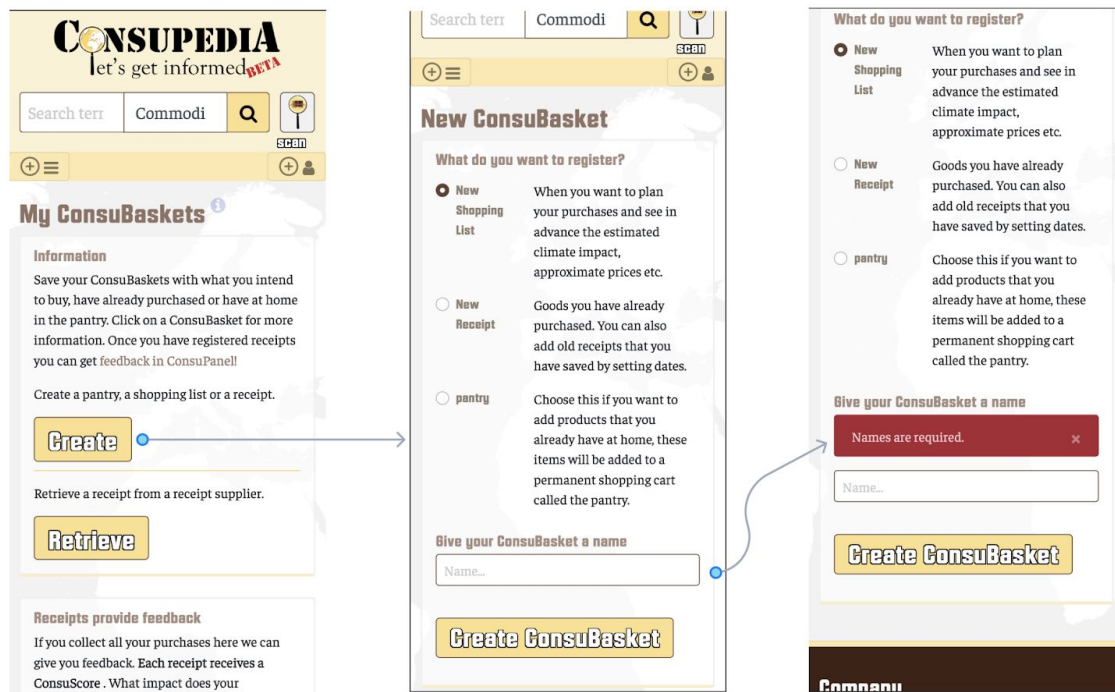


Figure 23: Creating a new basket

Aesthetic appeal of the application

While this is not part of the usability heuristics mentioned above, it must be noted that the application lacks an aesthetic appeal making it feel difficult to use the app. The contrast of the colors used along with the font style used reduce readability and the accessibility of the application.

5.4.2 Design Features identified

The following design features were compiled based on the analysis of the outcomes from the focus group and the heuristic analysis performed in section 5.4.1:

1. An overview of past and present products that users shop for
2. A shopping list with an easy representation/visualisation of products that adhere to goals and those that do not
3. A label on each product that easily explains information on the product such as 'vegan', 'animal product' etc
4. An explanation of labels used in a product
5. An easy way to look for information on product

6. A list of alternative brands for products chosen to allow users to swap if necessary
7. A feature to compare two products to enable make an informed choice making

Table 7 shows how each design feature aligns with usability goals and user needs

No.	Design Feature Identified	Users Pain Points addressed	Usability goal reached
1	Shopping pattern overview	Lack of Knowledge	Minimising user memory load
			Providing Feedback
			Being consistent
2	Shopping list shopping list with an easy representation/visualisation of products that adhere to goals and those that do not	Lack of Knowledge Lack of information while making grocery lists	Providing Feedback
			Being consistent
			Mimising user memory load
3	A label on each product that easily explains information on the product such as 'vegan', 'animal product' etc	Lack of Knowledge	Simple Natural Dialogue
			Speaking the user's language
			Providing shortcuts
4	An explanation of labels used in a product	Lack of Knowledge	Providing information
5	An easy way to look for information on product	Lack of information	Providing shortcuts
			Speaking user's language
6	A list of alternative brands for products chosen to allow users to swap if necessary	Clash of values and affordability	Simple and Natural Dialogue
			Minimising user memory load

7	A feature to compare two products to enable make an informed choice making	Clash of values	Minimising user memory load
		Lack of information	

Table 7: Design features addressing user needs and usability goals

5.4.3 Low-fidelity prototype

Based on the UX analysis of the Consupedia application and the design features identified in section 5.4.2, a low-fidelity prototype was created with a digital tablet and pencil. These prototypes were then tested for feedback with student colleagues and peers. The results and feedback received are described in section 5.4.2.6

Design

The design consists of four different screens. A user onboarding screen with an overview of the application, a home screen with actions and navigation to the settings, a product information screen with which users can compare to other brands offering the same products and a habit overview screen that shows the user's shopping habits over a period of time and a gives an overview of how much they match with their goals

User onboarding screen

Upon onboarding to the application, the user first sets their goals for the values of nutrition, environment and fairness. After which the user can also add allergens to their profile to ensure that products selected display this information as well. Once the user completes these actions, to ensure that the user understands the context and use of the application, a screen with an overview of what can be done with the app is shown to the user. This screen is shown at the right-end in figure 24

The values set in during the onboarding process can always be changed in the settings of the application.



Figure 24: onboarding screens

Home screen

Once the user onboards to the application, the application navigates to the home screen shown in figure 25. The home screen essentially allows users to create a shopping list. This is done through a search bar that is placed at the top of the screen. Each time a user tries to add a product by typing it into the search bar, it shows all the brands in which the product is available. The user can then choose the one he/she wishes to add to their shopping list; by clicking on the product, it is added to their shopping list. After the product has been added to the list, if the user clicks on the product, the application navigates to the product information page which gives detailed information on the product.

The home screen also has a menu through which the user can navigate to the other features of the applications such as overview of purchases page or settings page etc. These features are described below.

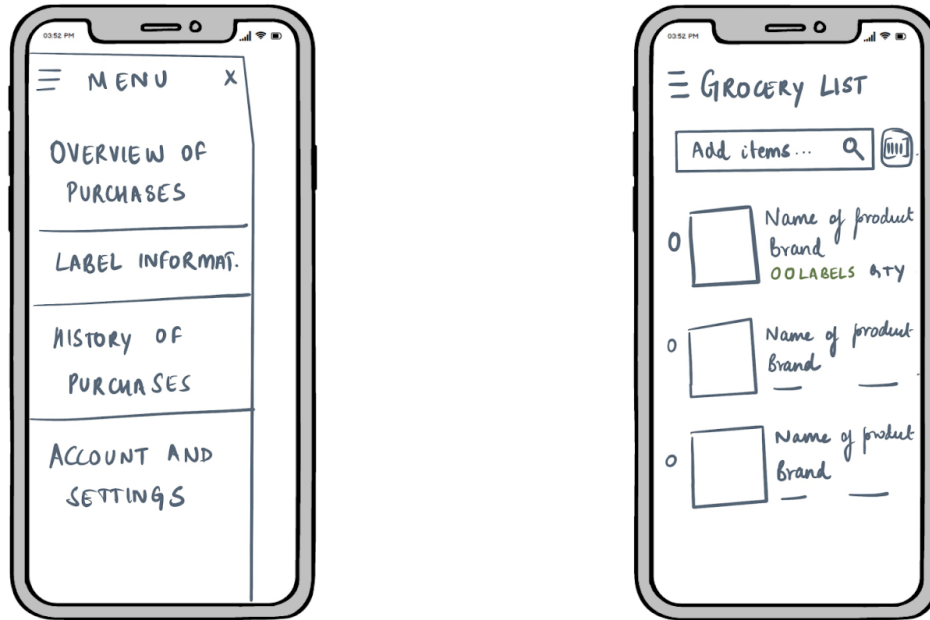


Figure 25: Home screen

Overview of Purchases

The overview of purchases provides a visualisation of the different values of nutrition, carbon footprint, water footprint and fairness in production for the products added to the shopping list. This is shown in figure 26 *It is assumed that if a product has been added to the list, the same product and brand will be purchased by the consumer.* The visualization also marks the personal goal set for the values of Nutrition, environment and fairness in production. When each value is viewed separately, the goal corresponds to that which is set by the user and when the user looks at the complete overview for all three values, an average goal value based on the goals set for each individual value is used. The menu to navigate back to the homepage or other pages of the application is also visible on this page.



Figure 26: Overview screens

Product information screen

This screen shows the various estimations for the values of nutrition, carbon/water footprint and fairness in production for the product chosen. Additionally once the user scrolls to the bottom of the information on the product, the application presents to the users alternative options or brands that offer the same product.

These alternatives can be compared with or swapped with on their shopping list. If the user clicks on 'Compare' the application navigates to the product information page of the chosen alternative where the user can make an informed decision to swap or go back to the original product they had previously chosen. This is shown in figure 27 Here again it is assumed that products chosen or swapped with will be the ones bought at the store.

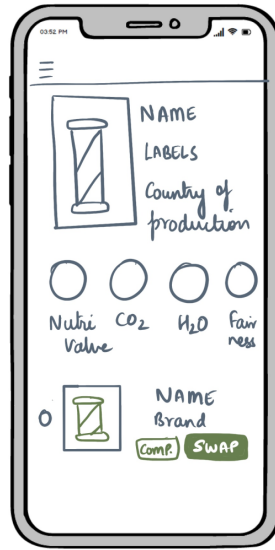


Figure 27: Product information screen

5.4.2.1 Feedback

Participants

The participants of the feedback session were student colleagues and peers who shop at Swedish supermarkets. The feedback was received from three participants who were all international students living in Sweden.

Feedback for these prototypes was received through a think-aloud study and semi structured interview of interacting with this prototype. During the think aloud study participants were asked to perform certain tasks. The details of the task have been listed in the appendix. The goal of this study was to understand if users perceived the functionality of the system that was being presented. The tasks were designed to test the user experience and usability of the application. After the think aloud study, an open-ended interview was conducted to identify functional problems with the application and it additionally gave the opportunity for the participants to discuss the opinions expressed during the think-aloud study.

Feedback from think-aloud study

User onboarding screens

The user onboarding screens were easy to understand and gave a good overview of the system.

Home screen

Three out of the four test subjects said it would be difficult to navigate through the shopping list when it was longer than 5 items due to the size of the cards.

Three out of the four test subjects said they would find it difficult to understand the labels used against the products in the list and pointed out that they would like to have a separate page where they can see this information which should be accessible from any part of the application at any given time.

Product Information Screen

All four test subjects wanted to see the relevance to their goals for each product in the product information screen. Information that was presented in circles seemed like buttons to two out of the four participants and they expected them to toggle and provided more information on toggle or on click.

Product Comparison - All four participants wanted to see information from both products at the same time to be able to compare efficiently. The current design of redirecting to a different page required them to remember a lot of information and that was a cognitive load for the users of the application.

Habit Overview Screen

Three of the four participants wanted to see the overview along with the shopping list. They pointed out that being able to dynamically see the visualisation change as they add, swap or delete products would be more motivating to make changes to the brands that better fit their goal

The feedback received on each screen is summarised in Table 8

Screen	Feedback
User Onboarding Screen	Good

Home Screen	Size of cards should be changed
	Seperate page with label information needed
Product Information Screen	Relevance of product to goal must be shown
	No navigation to seperate page for information comparison
Habit Overview Screen	Need to combine with grocery list view/home screen

Table 8: Summary of feedback on Lo-Fi Prototype

Feedback from Semi-Structured interview

The users pointed out that the general idea of the application was good. Each subject had different ideas on what kind of visualisation could be used. Two of the four subjects were used to seeing linear charts in other behaviour tracking applications such as Revolut which kept track of budget goals along with spending over time.

All four test subjects said that they would use the swap function and one pointed out that they would use it as long as the brands suggested were not difficult to find. One of the test subjects also suggested that price information must be available for making the swap on the grocery list.

5.4.3 High - fidelity prototype

Based on feedback received on the low-fidelity prototype, a high fidelity prototype was created with Figma.

Application Overview

The app consists of four different screens between which the users can navigate. The **user onboarding screens** which gives the user context of the application and allows users to set their initial goals for the different values of nutrition, environment and fairness in production. **The home screen** which provides an overview of the different actions the user can perform. **The Product information** and **Comparison screens** which allows users to see the various estimations for the two brands offering the same products that are being compared.

Figure 28 shows the ideal course of actions that can be performed with the application.

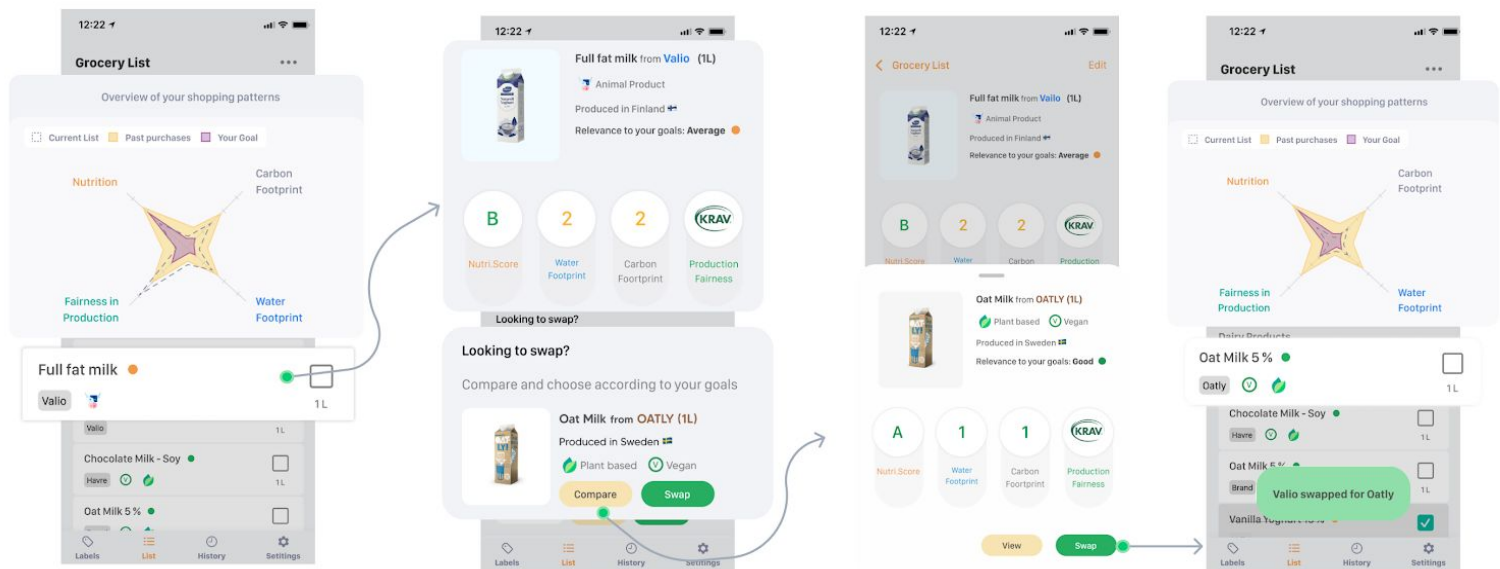


Figure 28: Application overview

Home Screen

Essentially the application is used to create a grocery list. It is assumed that users will buy the product and brand added to this list. The home screen shows an overview of the users' shopping patterns in comparison with their goals as shown on the leftmost screen of figure 29. Under this overview visualisation, there is a search bar through which users can search for and add products to their grocery list, shown in the middle screen of figure 29.

The home screen also has a footer navigation menu through which users can see the other features of the application.

Based on the feedback of the low fidelity prototype, the application also allows users to import grocery lists from other applications such as the phone's notes application or other grocery list applications that consumers use already.

The footer navigation menu allows the users to switch between views of information on labels, their shopping list, past purchases and settings of the application. By default, the app opens to the shopping list.

Feedback on the lo-fi prototype pointed out that footer menus were more intuitive for such applications as the different features available are easily discoverable when not hidden behind a collapsable menu.

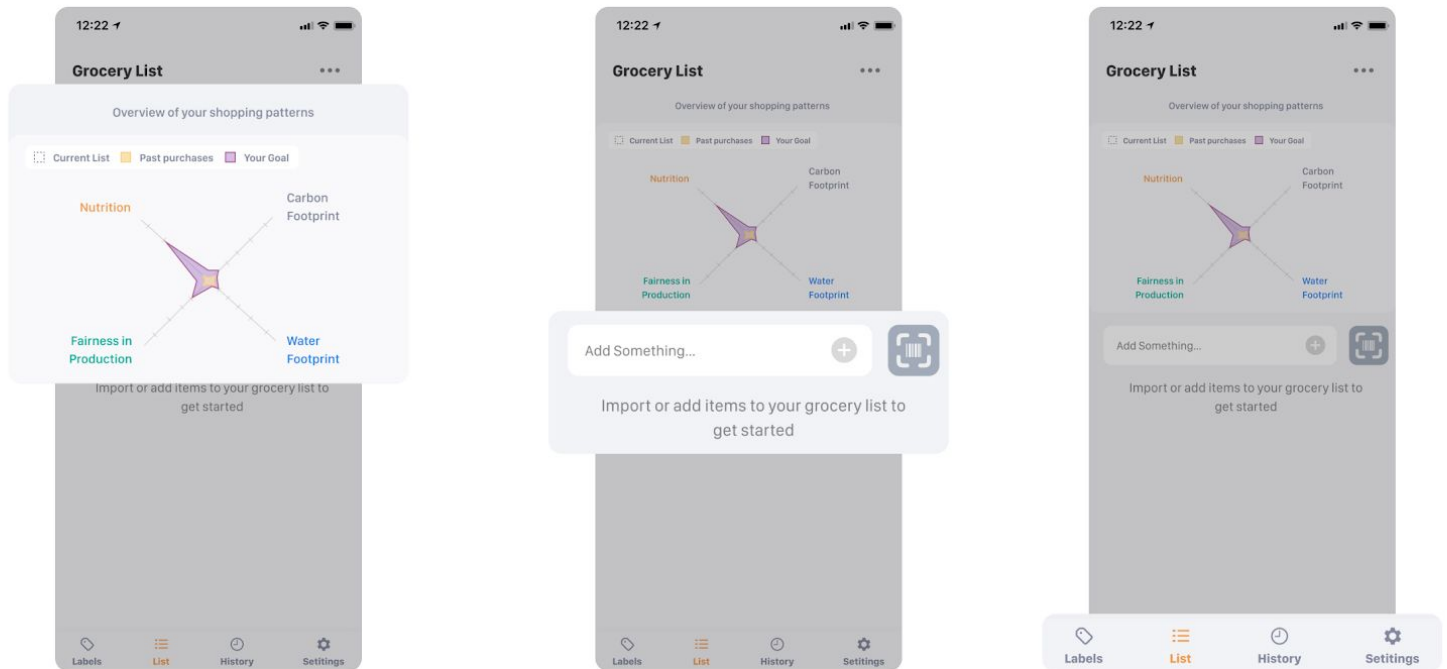


Figure 29: Home screen

Adding items to the grocery list

As the user types in the product that they want to add to their list, the search function dynamically searches to show the user all the brands available for that product as shown in figure 30. According to Usability heuristic number 1[16], visibility of system status: “Communicating the current state allows users to feel in control of the system, take appropriate actions to reach their goal, and ultimately trust the brand”[16], the items that appear in the search results also show the relevance to user goals (with the green, orange or red dot), the brand of the product and labels such as vegan, plant based etc are shown using familiar icons.

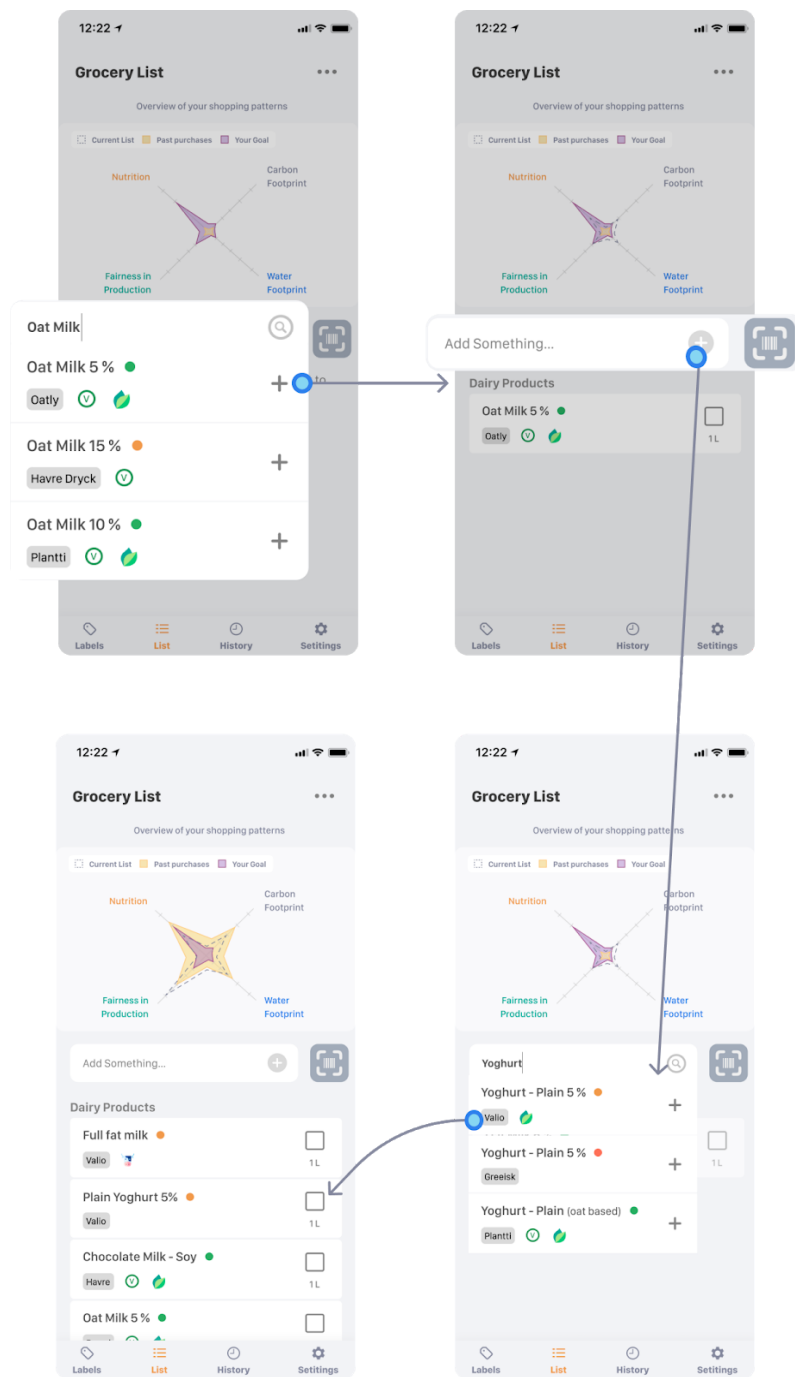


Figure 30: User flow to add items to list

Information on each item in the grocery list

Each time a product is added to the grocery list, the user is shown two types of information for the product added. One is the relevance to the goal and the other being the brand and its various labels. This is shown in figure 31.

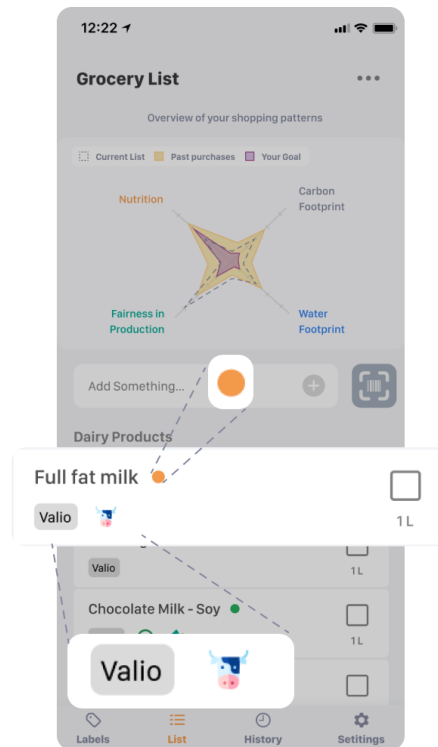


Figure 31: Item on a grocery list

The product entry has a red, yellow or green sticker to indicate the relevance of that product and brand to the users goal. The brand information is also shown with the labels that are associated with the brand and product. To ensure that the user is aware of the meaning of the icons/labels user, a tooltip with text is shown on the press of the icon.

Once a product has been added to the list, the overview visualisation, shown above the list, is updated to correspond with the data for the current list that is being edited. (Here it is assumed that products on the list are those that are actually purchased) This dynamic update was expected by all test subjects during the study of the first iteration of the application

Product Information Screen

Each time a product on the grocery list is clicked on, the application navigates to the product information page. The product information screen displays information on the country of origin, relevance to users' goal for the product and displays the estimations for the various values of Nutrition, Water Footprint, Carbon Footprint and Fairness in production. Additionally, the icon labels from the previous page are also shown for each product along with text for clarity. This is shown in figure 32.

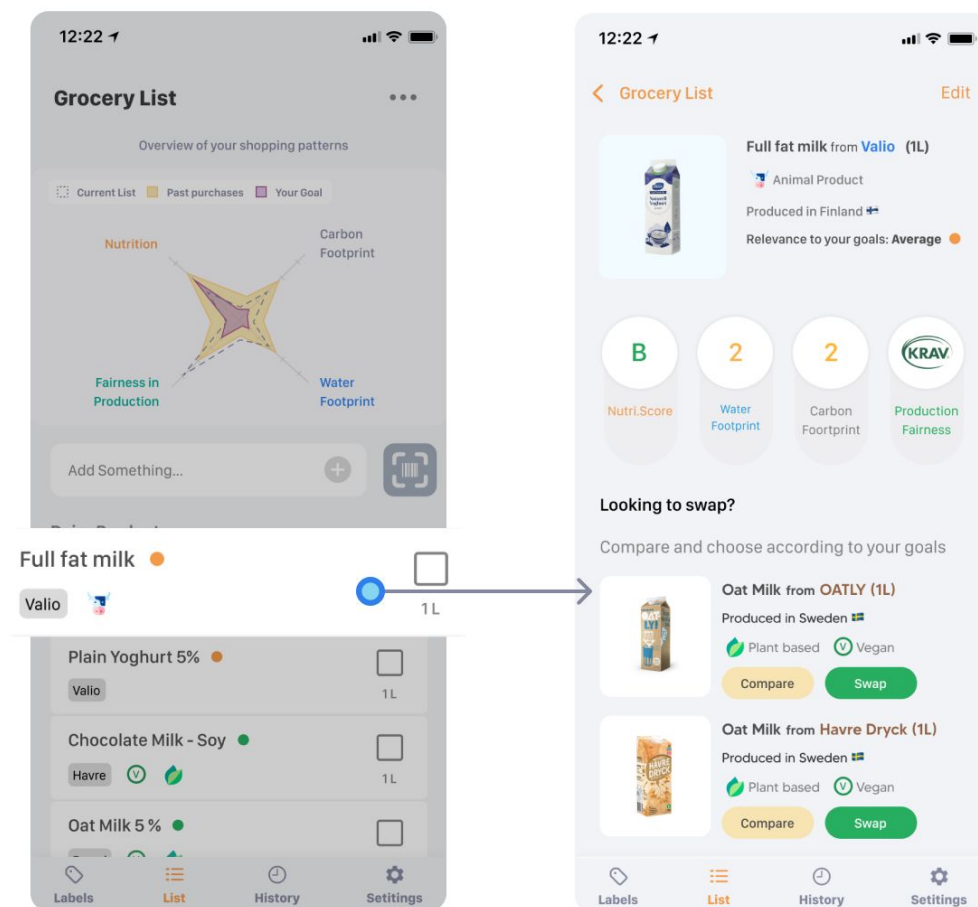


Figure 32: Product information screen

Alternatives suggested

When the user scrolls to the bottom of the product information, the application also displays a list of other brands offering the same product. The purpose of this being that, users can easily compare or swap to other brands based on their personal goals and desires. The comparison is explained in detail in the 'product comparison screen' section below

Product comparison screen

The application navigates to the product comparison screens when the user clicks on the compare button on the list of alternative brands shown for the same product on the product information screen. The comparison screen opens up as a bottom drawer allowing the user to see values for both brands of the same product which allows for users to compare and make an informed choice to swap or not. If the user chooses to swap, the original product and brand on the grocery list is replaced with the new one and the data for the visualisations is updated to reflect the changes made. This is shown in Figure 33.

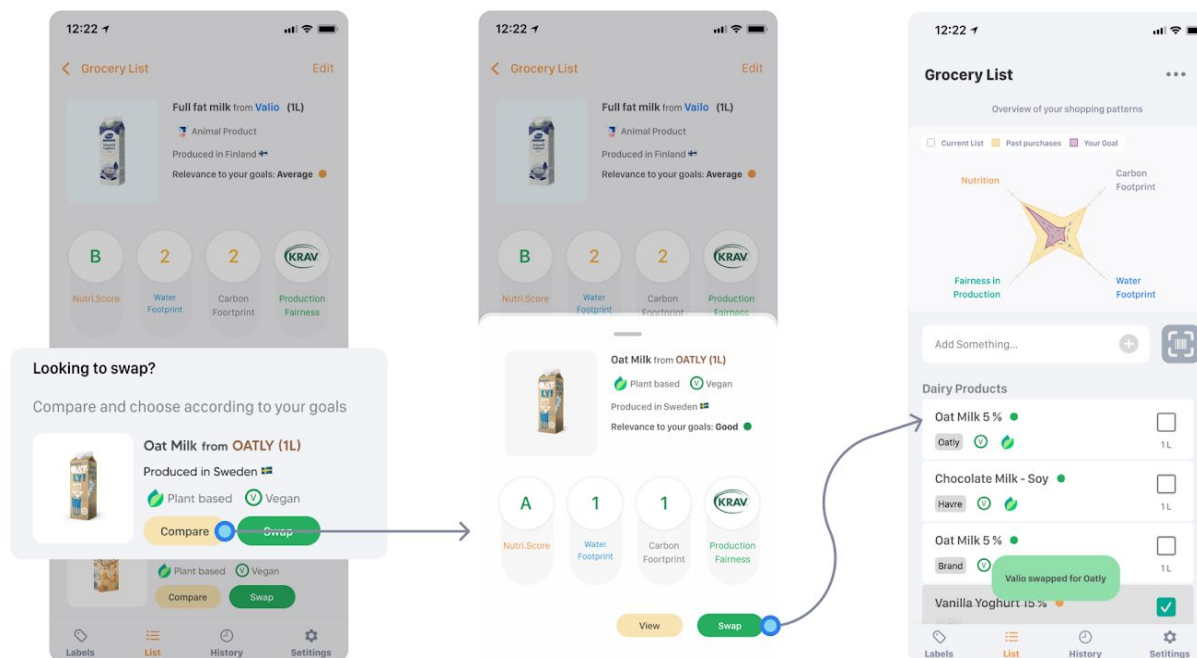


Figure 33: Product comparison

The bottom drawer also has a view button to allow for the users to see the suggested product in a separate screen with more detail, if desired. The user can however also chose to swap directly without comparison based on their need or previous experiences

Overview visualisation

It is assumed that users will purchase the items in the same brand as those added to the grocery list. In the home screen of the application, the top part is occupied by a visualisation that shows the overview of shopping patterns based on products added to the shopping list. The overview shows three different lines, one for past purchases, one for goal values and one for the current list that is being created. It is assumed that each time a grocery list is marked as complete, users purchased exactly what was on the list and therefore considered as 'past purchases'. The goal values depend on those that are set by the user on the application.

This study aims to compare two different types of visualization methods on the data for its dimensions on nutrition, carbon footprint, water footprint and fairness in production. For this purpose, one of the visualizations chosen is the line chart. The data for this is considered in such a way that each dimension is treated separately and plotted overtime to make it easy for the user to observe shopping patterns.

The other visualization method, the radar chart (spider chart) that considers the data to be multidimensional is chosen for comparison. This method allows for all dimensions in a single view making it easy for the user to get an overview of the distribution.

The two visualizations for comparison are shown side by side in figure 34

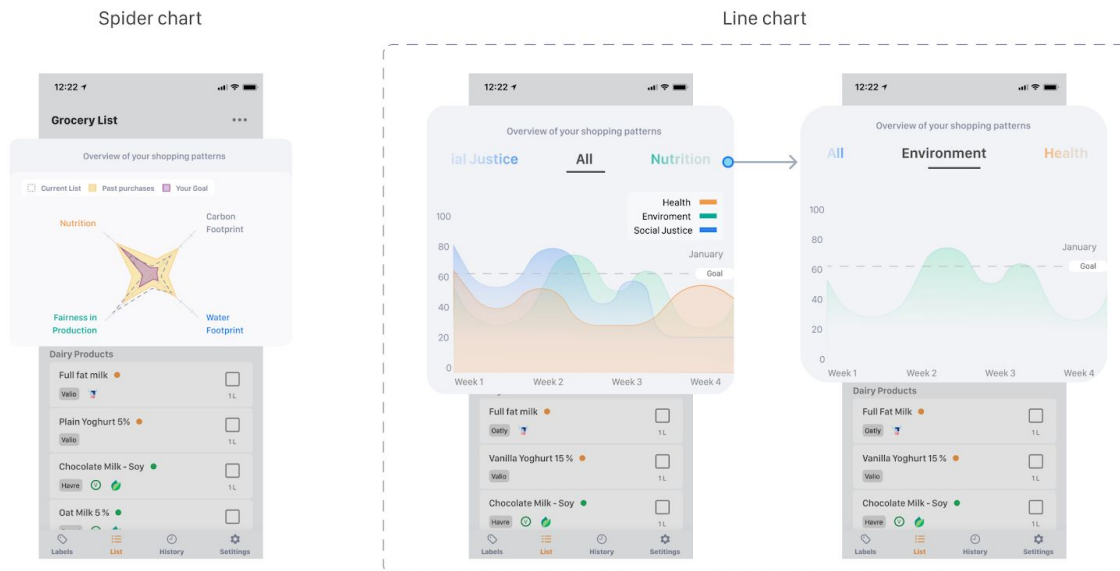


Figure 34: Visualization methods compared

Interaction with the visualization

Animation is used for the user to interact with the data.

For the line chart, the user scrolls through horizontally to see each dimension separately. The default view is at “all” which shows the representation for all the values and a legend which gives the user feedback on which line represents which value.

For the radar chart, each time a product is added to the shopping list the visualisation of the “current list” is dynamically updated.

For both, the past purchases update as and when the list is marked as complete.

6. Results

Participants

The final evaluation of the prototype was done with the help of an online usability tool MAZE Design. The test was distributed to the participants of the initial evaluations; who were Swedish bachelor students of the age between 18-33; two male and four female. To get more participants for reliable results, the test was also posted on Facebook. In total the test recorded twenty-four participants all of whom were Swedish, between the

ages of 18 and 70. Since the test did not record the gender of the participants from Facebook, gender distribution is unknown.

6.1 Prototype Interaction

All the participants were requested to complete five tasks, five open-ended questions and one closed-ended question with a Likert scale via an online usability testing application Maze design. Details list of tasks can be found in Appendix D.

The first task was to simulate the user onboarding experience. The next two tasks were to add items to the shopping list and look for product information. The fourth task was to compare information and swap to the compared-product on the grocery list. As testers made the switch, they were asked to observe the changes in the overview visualisations shown in the home screen, above the grocery list. For the last task, testers were then shown two different types of visualizations and asked to compare them based on understandability, preference and usability. Open-ended questions based on the practicality and usability of the action of swapping was asked at the end of the fourth task; and at the end of the last task, testers were asked about their preference of visualisation and reasons for the choice. The online test ended with a Likert scale on the understandability of the application as a whole.

6.2 Thematic Analysis

6.2.1 Product choices

Twelve of the twenty-four (*50% of total*) respondents say that the choice of product will change based on the price and eleven (*45% of total*) of them say the choice of their product will change when presented with better alternatives. One of the participants dropped off from the online test thus the response of that one participant was not recorded.

The following were the results of the thematic analysis on the opened ended question about why they would change their choices based on information shown to them
Themes identified were:

Personal Goals

Seven of the eleven participants (*63% of those who chose to change products irrespective of price*) that say that their choice of products will change irrespective of price, say that their reason for product change will be, due to their personal goals. Goals such as lowering their carbon footprint, developing shopping habits that are better for the environment and social welfare are considered important to them. Often these participants point out that they find it difficult to stick to their goals as finding the right

source for information on these values is difficult as it is spread across various platforms (at the time of writing this thesis). One of these seven participants noted that another driving factor to change their product choice would be to break out of old habits to try new products and brands that were better for both the test subject's health and for the environment. These participants also pointed out that comparison based on these facts would give the option to choose products of good quality for both the self and the betterment of the environment.

Impact

Six of the eleven participants (*54% of those who chose to change products irrespective of price*) that chose to switch products irrespective of price, reasoned that their choice of the product would change based on the impact it created. It was pointed out that the information and estimations on the values would "help buy the right food with the right information which is sometimes hard to find". These participants say that a function to compare and swap products would help in choosing those which have a low impact both socially and ecologically.

However, two of these six participants said that the choice of product will change only if there is a significant difference in the estimation of the values they consider important to them. Additionally, they say that buying the product/brand that best suits their goals would also depend on the availability of the product.

Budget

Twelve of twenty-four (*50% to total participants*) of the participants say that their choice of the product would change only if the price difference is not too high. However, three of these participants point out that if the impact of the product on their goals was really large then the price would not be an issue.

Clarity of information

A feedback that was consistent with all participants was that the range of values and their meanings must be conveyed clearly to drive a change. This meant that the range of the scales used for estimations of values must be defined by stating which value was the best and which the worst. Similarly, participants also needed information on the source of the facts being presented to verify the credibility of the information that they see. Additionally, participants also wanted a detailed view of the information on health, environment and social fairness which would drive the choice. This meant that users wanted nutritional values such as protein, carbohydrate and fat information etc. on the products to ensure that the changing products do not compromise on aspects that are important to them.

6.2.2 Visualisation choice

Sixteen out twenty-four (*67% of total*) of the test respondents liked the radar chart in comparison to the line chart shown.

The following were the results of the thematic analysis on the opened ended question about the reason for the choice of visualisation

Impact

According to the sixteen participants (*67% of total*) that chose the radar chart, it showed an easy overview of their current, past and target-goal shopping patterns. It was pointed out by three of these sixteen participants that this overview invites them to reprioritize. The test subjects felt that the radar chart showed them how their choices could fit to reach their targets. Four of these sixteen pointed out that with the radar chart it was easier to see where the goal and the impact of their choices lie in comparison to the line chart. Two of these sixteen participants pointed out that identifying this fit to reach goals using the line chart was more difficult as it required more cognitive strain.

Interactions

Eight of the twenty-four (*33% of total*) participants felt that the line chart was more fun and engaging. However three of these eight participants found that a linear chart could easily grow to have too many lines and scrolling through the multiple options could become tedious. In comparison, the interactions presented by the spider chart were easy and simple providing a quick overview at a glance making it easier to perceive and retain information.

Timeline used

Three of the sixteen participants (*18% of those that chose the radar chart*) that chose the radar chart felt that a timeline is not relevant to grocery shopping as they shop intermittently. This was also further strengthened with the initial user research where it was found that from among 76 responses, although a majority shopped in regular intervals of time 30 of the respondents shopped intermittently. Thus in this case, the radar chart was the preferred choice. However, eight of the twenty-four (*33% of total*) total participants did feel that the line chart would show the effects of their choices for a long term analysis thus making it possible to predict how choices can affect their goals.

Ease of understanding

While eight of the twenty-four (*33% of total*) total participants felt that the line chart was well known and commonly used by most mobile applications which made it aesthetically

pleasing; sixteen of the twenty-four participants (67% of total) felt otherwise. The majority of the participants felt that more information was conveyed in one single view with the radar chart and it was easier to grasp.

6.3 Answering the research questions

Research question 1: In which phase of the grocery shopping process do users look for information?

The outcomes initial evaluations of the empathize, define and ideate phase described in sections 5.1, 5.2 and 5.3 were used to answer this question. Additionally, this was verified with the usability evaluation on the prototype by focussing the application on, creating grocery lists.

The results of the evaluations were that users look for information on products in the planning phase of the grocery shopping process. From the outcomes, it was clear that the choice of products and search for information on products were done while making a grocery list before consumers go to the supermarket.

Research question 1.1: Will their choice of product change based on the information presented to them?

This question was evaluated with open-ended questions based on the tasks pertaining to products swapping in the prototype interaction, as part of the online usability test. The tasks are described in detail in Appendix D. The responses were then analyzed thematically, detailed in section 6.2.1, to answer this research question.

The outcomes of the analysis suggested that users will change the product based on information presented to them if the product is not largely over their budget. Thus concluding that if budget was not a concern, consumers would change to buying products that better match their goals to develop better shopping habits. However, it must be noted that ease of availability of these products in supermarkets is also important.

It is interesting to note that none of the participants responded negatively. This implies that there is a motivation for the behaviour change to occur, given the right opportunities and capabilities through the information presented and assuming no financial strain. This further justifies that the target behaviour can be achieved.

Research question 2: What kind of visualizations methods on the data of groceries will best enable consumers to make informed choices?

To answer this research question, one close-ended question asking participants to choose between two different types of visualizations by comparing the two shown side by side during the test on the screen and an open-ended question asking the reason for the choice was used. Thematic analysis, described in section 6.2.2 was done on the open-ended question to understand the reason for the choice and weigh the pros and cons listed by the participants.

Based on the outcomes of the close-ended question, it was clear that a majority of the participants preferred the radar chart with the values of nutrition, carbon footprint, water footprint and fairness in production on its axis. The analysis of the open-ended question further suggested that the all-in-one data visualization on the radar chart with the estimations for the various values for past purchases, current purchase (based on their shopping list) and target goal to be reached, would help in prioritizing brands and making informed choices. Additionally, it was observed that participants found it easier to grasp the information displayed by the radar chart in comparison to the line chart.

It must be noted that the application assumes that products and brands that are added to the shopping list are the ones that are actually bought at the store as well. Each time all items of the shopping list are checked as done/bought, the list is recorded as past purchases. Real life observations were not possible in the timeframe of this thesis.

Research Question 3: To what degree do consumers understand this information gathered while using the suggested application?

A five-point Likert scale from very bad (1), bad (2), average (3), good (4), very good(5) was used to assess how well users understood the application. Additionally, the thematic analysis carried out for the open-ended question based on product choice tasks were used to analyse the sentiments and opinions of understandability of information gathered while using the suggested application.

The results of the Likert scale showed that 65% of the participants responded 4 out of 5. However, the thematic analysis on product choice, discussed in section 6.2.1 revealed that for a comprehensive understanding of the information presented in the application, it is required to clearly define the ranges of the estimations used along with the highest value possible. It is also required to clarify on the best and worst estimations for the values of nutrition, carbon footprint, water footprint and fairness in production.

7. Discussion

In this degree project, a design thinking process was employed to answer the research questions asked in the study. Different qualitative data collection methods were used in each stage of the design thinking process to synthesise the outcomes and use them in the subsequent stage. The results based on the outcomes of this study, can be summarised as an application that has features to provide goal orientation along with an overview of shopping patterns during the planning phase of the grocery shopping process for consumers of retail supermarkets, could bring about a value-centric shopping pattern. However, affordability must also be given importance and probably added to the values of a product as half of the participants in this study pointed out that the price of an item would dominate the choice made.

It must also be noted that the results were based on qualitative analysis such as open ended questions on the practicality of the features suggested by the application which help in performing sustainable actions. Actual observations of behaviours were not possible in the duration of this thesis and it is often noted that there is a mismatch between what users say and actually do.

Design thinking process

In this thesis, the design thinking process with its emphasis on user research was particularly useful because it was necessary to research the various phases of the grocery shopping process to identify which phase needed intervention to bring about the target behaviour. Thus, the design thinking process helped to ideate on the different phases of the grocery shopping process and identify where users' pain points lie and what kind of design features address those pain points. The process' emphasis on ideation and user research also allows for large amounts of data collection through the various methods used in each stage. The emphasis of the methods used in the ideate stage to generate a large number of ideas often reveals innovative solutions. Furthermore, the analysis of this data helps identify design features that address *all* the unmet needs of the user.

Although there are various different methods that can be employed in each stage, the ones chosen for this thesis were based on the objectives/expected results of each phase. Following the five stages of the design process like a recipe helps not only in identifying and addressing unmet users' needs but also in identifying the various stakeholders of the system and ideating to come up with solutions that are beneficial to all as well.

Application Features and Design

The phase of grocery shopping experience

Although the application was designed for users to make informed choices while making a shopping list, the application can also cater to those users that would like to use the features such as tracking their past purchases. For this purpose, it has to be mentioned that although by default, the application opens to the grocery list feature, another feature to track past purchases through the scanning of shopping bills can be added. This page can be navigated to via the footer menu on the home screen, that is labeled as history.

Choice of visualisation

The exact correlation between data visualisation and behaviour change has not been established but it can be argued that the visualizations allow users to analyze their current and past patterns to gain knowledge on how to improve future choices. This, in turn, affects the psychological capabilities of the user which would increase the motivation and bring about a change in behavior to reach the desired target goal.

Although users were not given specific tasks on interpreting the data represented by the visualisations, which could have estimated their real understanding, the thematic analysis performed suggested that the perception and interpretation of the data were done by the test subjects as expected.

Change in product choice

While it is interesting to note that all participants say that they will swap products to those that match better with their goals, it has to be acknowledged that people often say yes to sustainable actions but when it comes to actually doing them, the outcomes might not be the same. Due to the short timeframe of this thesis, observations from real-life scenarios were not possible. However, if this feature is developed and used in real life, observing purchase patterns over a period of time by comparing shopping lists and receipts to identify mismatches or perfect matches would reveal if the target behaviour is actually achieved.

Understanding of the application

From the thematic analysis carried out for the choice of products, it was evident that the hi-fi prototype that the users interacted with was unclear on the scales and ranges used for the various estimations on the values of nutrition, carbon footprint, water footprint and fairness in production. Test subjects also wanted the source information to verify

the credibility of the information shown to them. This should thus be included in the design before it is being implemented for the final application.

Method critique

This thesis was conducted during a global pandemic making it not possible to meet test participants in real life.

Methods used in the user research phase for the cognitive task analysis, to learn about purchasing habits of the participants required them to use an audio recording device to record their choices. This compromised on the internal validity of the study as participants were conscious about their choice and sometimes even changed because of the thinking aloud process. Under normal circumstances, a fly-on-the-wall observation would have been conducted and analysed to understand the thought process of the test subjects.

Conducting brainstorming and card sorting exercises proved challenging via Zoom. Sharing the screen to allow test subjects to see each others' card sorting exercise might have affected their thought process thus questioning the validity of the study. Although each test subject was given their own login and credentials on Figma for the exercise, there was troubleshooting making it impossible to not reveal each others' screens while performing the exercise.

For the visualization methods used, a dummy visualisation of data was used to compare between the two chosen methods. Since it did not reflect real data that could change dynamically there were no data interpretation tasks given as part of the user test. Test subjects evaluated the methods based on their view and understanding of the overview shown. Additionally for all tasks, the radar chart was shown and the line chart was introduced only in the comparison task section of the user test. Since the test subjects were exposed to the radar chart for more tasks and a longer period of time, there could have been a bias amongst the test participants towards the radar chart.

It must also be noted that the data for the visualisation on application assumes that products and brands that are added to the shopping list are the ones that are actually bought at the store as well. Each time all items of the shopping list are checked as done/bought, the list is recorded as past purchases. However, this might not be the case in real life as consumers tend to have differences between their thoughts and actions. Real life observations were not possible in the timeframe of this thesis.

For the question on product choice, it must be noted that, when an open ended question is posed with an obvious good/right answer it is difficult to get unbiased opinions from

the test subjects. Therefore, it is necessary to implement such a feature and observe over a period of time whether consumers actually, in practice change the product based on goals. Testing of this was not possible in the time frame of this thesis.

Future Work

Going forward, more research can be conducted on the type of visualisation and methods to display product information. Since most participants pointed out that the product information screen should provide more context on the ranges of values used and the sources of information, these screens must be re-designed to show these for clarification and understandability for the users of the application. This design can further be tested for feedback before implementation.

Tests focussed on interpreting the data used in the visualisation must be performed to ensure that the information presented is perceived as expected. This was not done in this study as this thesis was focussed more on the design and dynamically changing data for interpretation tasks require the development of the application. Additionally, the visualisations used for testing purposes were based on dummy data but when the application has been developed for use it can be tested with real-life scenarios to observe if it drives a behaviour change.

8. Conclusion

Consumers of retail supermarkets consider many attributes when it comes to choosing a product. Providing them with an overview of these different attributes and enabling them to see the impact of their choices will help them make decisions that are both good for the planet and their health. The feature of gathering data every time a shopping list is made or imported into this application, allows the system to gather data to present an overview of shopping patterns to the users. Advantage of this being that it does not require any additional effort from the users to remember to log their past purchases to gather a history. This would make it easier for consumers to make improvements to their choices to reach their personal goals and bring about a positive behaviour change.

The visualisation methods adopted for this use case are based on previous research conducted in the field of information visualisation and commonly used design patterns. Based on the evaluations conducted, the majority of retail consumers shop in

intermittent time periods making the radar chart a popular choice. Thus, an implementation for datasets that contain multiple dimensions which are not temporal, radar charts could prove to be useful. Additionally, the evaluations suggested that details and changes in data represented by the radar chart were easier to perceive for the end user.

Improvements and iterations on the current design and choice of visualisation should be considered before implementation. Tests must be conducted with more tasks focussed on interpretation of the data to ensure that users have the correct understanding of the data being presented.

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Appendix A: Initial User Research

Online survey

This section replicates the google form that was sent out to the participants.

Your shopping choices

Hey!👋 This questionnaire is here to understand your grocery shopping habits🛒

This questionnaire will take about 15-20 mins. Please grab a cup of coffee/tea ☕relax, and answer the questions, as best as you can 😊

Your name

If you would like to participate in the study that follows this questionnaire, please fill in your name. Your name will be used only by me for identification and your responses presented in the thesis will be anonymous. If not please leave it blank :)

1. How old are you? *

I need this information for the demographics of my study, all responses will be anonymous. I will not use this information otherwise.

- 18-25
- 25-35
- 35-45
- >45

2. Gender *

- Female
- Male
- Prefer not to say

3. When you shop for groceries, who do you shop for? *

- ☐ Only myself
- ☐ For myself and others adults only
- ☐ For myself, other adults and children
- ☐ For myself and other children only

4. How many people do you live with?

- Alone
- 1-2
- 3-5
- More than 5
- Other:

5. Do you plan your purchases in advance? *

- Yes
- No

6. If yes, how do you plan them in advance? *

eg: I use xyz app or I plan with a grocery list, etc. Please answer this in detail.

7. How often do you shop? *

eg: once a week, I buy whenever I need stuff, etc.

8. What is most important to you when you shop for groceries? *

- ☐ Price
- ☐ Nutrition
- ☐ Popularity of brand of item
- ☐ Ethical Production - eg: fair-trade, etc.
- ☐ Sustainable factors such as CO2 footprint etc

9. How do decide which brand to choose? *

Please describe 3 reasons as to why you chose a particular brand of item. For example, I choose Oatly milk since it is plant based and ecological, it is not expensive and it tastes good.

10. Is ethical and sustainable shopping important to you? *

- Yes
- No

11. What information do you normally look for in a product? *

When you are at the store, where do you find this information? *

- ☐ On the package
- ☐ Google
- ☐ Other:

12. Have you ever lacked information on a product? *

- Yes
- No

13. If yes, where do you look to find more information? For example, if the product's country of origin does not exist on the product *

- Google
- Ask the store manager
- If I don't see information, it does not matter to me anymore
- Other:

14. How do you know if a product is ecological? *

eg: I look at the labels and stickers on them, I search for information online w.r.t the product, etc.

Your answer

15. Are there some products you avoid buying? Why? *

Eg: yes, chia seeds, I am allergic or cow's milk because I am vegan or no I have no restrictions, etc.

Your answer

16. Do you use mobile apps or other such technology to aid your grocery shopping? *

- Yes
- No
- If yes, what apps and how do you use them?

17. Please describe what apps you use and for what purpose and part of the shopping experience.

Your answer

18. Do you consider sustainability, fair trade or other ethical factors when you shop? *

- Yes
- No

19. If not, what do you lack that makes ethical shopping difficult for you?

For example: I do not have enough information on the product or any other reasons that you feel makes ethical shopping difficult for you

Your answer

20. Do you know what the labels on the products mean? *

- Yes
- No
- Maybe

21. What do you feel that supermarkets lack when it comes to helping you choose products? *

Your answer

You're done 🎉 Thank you so much for taking the time to fill out this questionnaire!

Cognitive task analysis

This section shows the instruction sheet given for the cognitive task analysis

Record your grocery shopping: (estimated time: +15 mins to usual shopping time)

This activity requires you to carry a phone which can record audio as you shop.

Note: I used earphones with a mic to record as it was easy to talk into the earphones.

If you are shopping online please switch on the recording as you sit down to order and please record your thoughts for every item that you add to the cart :)

Please switch on any audio recording app on your phone when you enter the grocery store/sit down to shop online and follow the instructions below

1. Start talking into the recording about what you feel as you walk through the store
2. Each time you pick up an item, please record the item you picked up its brand, how much and state the reasons for the choice.

For example, I recorded something like this: I am picking up one (quantity) Oatly (brand) chocolate milk (type) since I try vegan alternatives and this is an affordable and ecological replacement to normal milk (reasons) or I am now picking up Garant (brand) basmati rice (type) since this is the cheapest option that I see at the store (reason) and I am buying 5kg (quantity) to save up on the price (reason)

If you feel there are multiple reasons for the choice, please state them all.

3. Remember to talk your mind as freely as you like (Would be really cool if I can get a recording of everything that goes on in your mind when you shop for groceries) 😊

Once you are done, please upload your recording with the file name: firstname_lastname [here](#):

<https://drive.google.com/drive/folders/1WMWqeygrJSzQZvbt-W2oQF4x26rEpgwQ?usp=sharing>

Feel free to use any format :)

Personal Inventory

This section shows the excel sheet that was filled by the participants

Personal Inventory: (estimated time 30 mins)

1. Please note down the items that you currently have in your pantry/fridge/freezer/cabinets in this sheet linked below 📌 (everything from the grocery store that you have at home up until your last shopping trip)

Please make sure to add in the sheet that **corresponds to your name**

Please feel free to add columns if need be

Sheet filled by participants:

Vegetables and Fruits		Dairy, cheese and tofu		Bread and biscuits		Spices		Rice, pasta and cereals		Coffee, tea and cocoa		Beans and canned goods		Flour and other ground things		Baking items		Toilet items		Frozen/Fridge foods		Frozen/Fridge items		Juice and Ice cream		Nuts and berries		Chips and snacks		Bathing products and toothpaste	
Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T	Br	T
a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y	a	y
n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p	n	p
d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e	d	e

Appendix B: Focus Group Tasks

Brainstorming session

This section outlines the tasks and outcomes of the brainstorming session

1. Discuss consupedia application
2. Explain value tensions and values of the current system
3. Take ten mins to identify 3 value tensions in the grocery shopping process
4. Let's discuss them

5. Another 10 mins to identify design features that provide a trade-off between these values
6. Discuss ideas generated

Outcomes

List of value tensions identified

Participant 1: Nutrition vs Sustainability vs affordability

Participant 2: Sustainability vs affordability

Participant 3: Fairness vs affordability

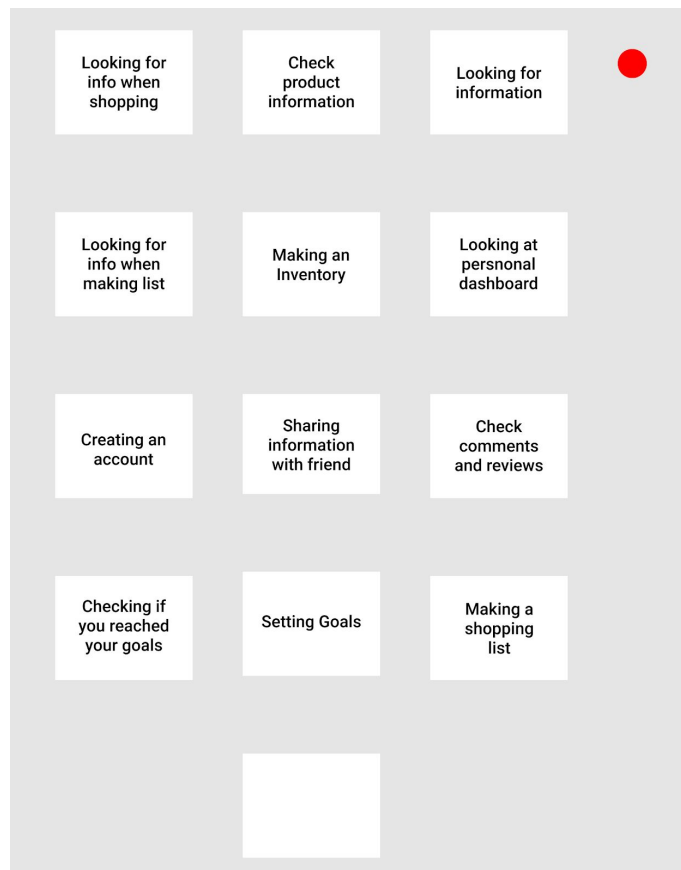
Participant 4: Nutrition vs Fairness

Participant 5: Nutrition vs Sustainability

Participant 6: Sustainability vs affordability

Card Sorting exercise

This section shows the card sorting exercise given to the participants. The red dot was used to mark features that participants thought were not useful. A blank card was placed for participants to add design features they thought were missing.



Appendix C: Initial Prototype Testing

Think aloud study

The following tasks were given in the think aloud study

1. Add items to your grocery list
2. Look for product information on added item
3. Compare with another brand and swap
4. Look at overview of visualisation, detail what it tells you

Semi Structured interview

1. How useful do you find this application?
2. Does the swap functionality seem practical to you?
3. How would you like to see the visualisation?
4. Does that change your choice?
5. How easy is it to compare products?

Appendix D: Final Prototype Testing with MAZE

1. Value-centric Grocery List App

Context Screen

DESCRIPTION

A user test for an app that helps you make smart grocery lists

What makes it smart?

You start off by settings personal goals for nutrition, environment and fairness in production for the groceries you buy. Every time you add an item to the list you can see a visualisation showing nutrition, environment and fairness values for each product, to show you how these match your goals.

If a product doesn't match, the app gives suggestions to swap to products that do.

Please follow along

2. Click through the 'Next / Got-it' buttons to move forward

Task 1: User onboarding

Along with setting your personal goals on the values mentioned before, you can also mark allergens so the app can base its recommendations on that data too :)

These would work as shown in these screens as you click through 'next'.

Since this is only a prototype I have pre-set the goals for the values of nutrition, environment and fairness for the purpose of this test.

You will not be able to change them here

However, in the real scenario, you would be able to edit these fields.

3. Initial screens for first use

Context Screen

DESCRIPTION

When you use this app for the first time, it would let you add items to your grocery list with a simple search bar. As you add items you would be able to see a visualization of the data on the items added for their values of nutrition, environment and fairness in production. As shown in this screen

4. Add two items to the list

Task: Go ahead and click the search bar then click on the first item in the dropdown that appears. **Do this two times** to see the visualizations change as you add items.

Since this is only a prototype, you will not be able to type into the search bar and interact with it, you can only click on the options that appear in the dropdown which simulate a search. The last screen you see here shows a view with a list with multiple items in it.

In the real case, you can type as you normally would.

5. What kind of visualisation would you like to see?

In the previous screen, you saw a spider chart showing you an overview of your products and their values. Here is another kind of visualization of the same data. Please take a minute to think about which of these makes the most sense to you?

The screens are shown adjacent to each other here for you to compare. Choose the one that you understand best.

The next question will ask you to elaborate on your thoughts about these.

1. The left screen - spider chart
2. The right screen - line chart

6. Why did you choose that visualisation?

Open Question

Please elaborate on which visualisation appealed more to you and why you understood it better. Please feel free to write down all your opinions and thoughts :)

7. Switch to a brand that fits your goal

Task: Click on full-fat milk and see the product description.

Now, let us imagine that you want to switch to a different product that matches your goals.

For this purpose, please try and:

1. Compare with Oat milk from Oatly
2. Swap to the oat milk on your list.

8. Would you use the swapping feature?

Please think about using this in your grocery list making experience. When you make your list if you are given an option to swap to products that match your goal, would you do it? Would this be realistic/practical to you?

- Yes, because it is practical for me
- No, I do not see a reason to swap
- Yes, only if it is in my budget to do so (I would need price information to make a swap)

9. Does the choice of products in your grocery list change based on the information shown to you? Why?

Open Question

Please elaborate if you would swap to products that better match your goals based on the information presented to you. Yes or No and why?

10.How well did you understand the information on this app?

Opinion Scale

Please think about the information shown on the groceries and the visualisation (both line and spider charts, the final real-app will have the one that you understand best).

The screen shown here is an example using the spider chart, if you liked the line chart more imagine that, that would be used here. So, please rate based on how understandable the data is to you.

1-very bad 2-bad 3-average 4-good 5-very good